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NOTES ON THE pH MEASUREMENT OF NATURAL WATERS

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In the purification of natural water, pH measurement has become one of the important factors that have placed the processing of water supplies on a scientific basis. On account of its simplicity and rapidity the colorimetric method of pH determination has been widely adopted. This method, however, is subject to a number of limitations. Unless the "isohydric technic"(1) is used, an indicator solution will affect the original pH value of a very dilute or weakly buffered solution. Salt, colloid, protein, and solvent effects are likely to introduce specific errors dependent on the nature of the unknown solution. Personal error, inherent in the photometric method involved, will also influence the results.

In the colorimetric pH measurement of the Manila water supply the error due to "indicator and salt effects" is probably most significant when the usual procedure of Clark(5) is followed. Since the salt concentration of our water is approximately 0.001*N* (as $CaCO_3$), it would be desirable to determine the effect of the indicator solution on the pH of the water and the salt effect, on account of the difference in salt concentration between the water and the buffer solution (0.1 *N*) used for the color standards.(7) The "indicator effect" can be determined by using indicator solutions of adjusted pH values, while the salt effect can be evaluated by comparing the electrometric and the colorimetric pH values of water samples. For the latter the procedure should be a direct comparison with the hydrogen electrode,

but Burton(4) has shown that due to the slight buffering characteristics of natural waters the hydrogen electrode is inapplicable; however, these same investigators found that the glass electrode gave the most reliable results with natural and treated waters. The glass electrode was therefore chosen for the electrometric method. Other methods of evaluating salt errors from indicator dissociation constants and absorption indices are given respectively by Kilpatrick(6) and Wingfield.(8)

EXPERIMENTAL PROCEDURE

Water samples were obtained from different points along the course of the water being treated at the Balara Filtration Plant. The colorimetric apparatus consisted of a La Motte Roulette comparator and color standards. Indicator solutions were prepared from La Motte indicator powders. The glass electrode was a Coleman pH Electrometer Model 3D. Based on actual tests, under ordinary laboratory conditions, the precision of this electrometer was well within ± 0.05 pH, exclusive of any error in the buffer reference solution. The adjustment of the pH values of the indicator solutions was made with the glass electrode. No attempt has been made to observe extreme refinement in the measurements made, such as elimination of CO_2 interference and temperature variations.

RESULTS

The results of comparative tests between the colorimetric and glass electrode pH measurements are shown in Tables 1 and 2. The salt concentrations were based on the total alkalinity of the water samples, expressed as $CaCO_3$.

In Table 1 the colorimetric tests were made with the pH of the indicator solutions (phenol red and brom thymol blue), adjusted to the values given. The results in Table 1 show no appreciable variation in pH value of a given water sample when tested with these adjusted indicator solutions; in other words, the effect of the indicator on the pH of the sample is negligible. These results are in agreement with the findings of Acree and Fawcett(1) who showed that up to 1 : 50 dilution of 0.05 M buffer solutions no appreciable changes in pH of the diluted solutions occur when tested with adjusted indicator solutions. It can therefore be stated that the adjustment of the indicator solution is unnecessary in the colorimetric pH measurement of natural and treated waters. Using adjusted in-

TABLE 1.—*Results of comparative tests with colorimetric and glass electrode pH measurement, with the pH of the indicator solutions adjusted.*

Water sample.	Alkalinity as $CaCO_3$.	Salt concentration.	Glass electrode.	Colorimetric pH values.							
				Phenol red.					Brom thymol blue.		
				Solution 1, pH 6.8.	Solution 2, pH 7.1.	Solution 3, pH 7.4.	Solution 4, pH 7.7.	Solution 5, pH 7.9.	Solution 1, pH 6.4.	Solution 2, pH 6.7.	Solution 3, pH 7.2.
	p. p. m.		*pH.*								
1	35	0.0007*N*	8.1	7.7	7.7	7.7+	7.8—	7.8—			
2	28	0.0006*N*	7.1	6.8	6.8	6.8+	6.9—	6.9—	6.9	6.9	6.9+
3	31	0.0006*N*	7.4	7.1	7.1	7.1+	7.2	7.2	7.1	7.1+	7.1+
4	30	0.0006*N*	7.6	7.3	7.3	7.3+	7.4—	7.4—	7.3	7.3	7.3+
5	30	0.0006*N*	7.4	7.1	7.1	7.1+	7.2—	7.2—	7.1	7.1	7.1+
6	120	0.0024*N*	8.0	7.8—	7.8—	7.8—	7.8	7.8			
7	110	0.0022*N*	7.5	7.3	7.3	7.3	7.3+	7.3+	7.3+	7.4—	7.4—
8	64	0.0013*N*	7.4	7.1+	7.1+	7.2	7.2	7.2	7.2—	7.2—	7.2
9	64	0.0013*N*	7.8	7.4+	7.4+	7.4+	7.5	7.5	7.5+	7.5+	7.6
10	64	0.0013*N*	7.5	7.2	7.2+	7.2+	7.5	7.3	7.3	7.3	7.3+

dicator solutions, Black et al. (2) reported significant variations in the pH of the "synthetic" water they used for laboratory coagulation experiments. He remarked, however, that "it should not be inferred that the variations will be as great in the case of natural and treated waters."

TABLE 2.—*Results of comparative tests with colorimetric and glass electrode pH measurements, with the pH of the indicator solutions unadjusted.*

Water sample.	Alkalinity as $CaCO_3$.	Salt concentration.	Glass electrode.	Phenol red.	Brom thymol blue.
	p.p.m.		*pH.*		
1	120	0.0024*N*	8.1	7.8	----------
2	110	0.0022*N*	7.5	7.3—	7.3
3	50	0.001 *N*	7.4	7.1	7.1+
4	51	0.001 *N*	7.7	7.4	7.4
5	51	0.001 *N*	7.5	7.1	7.1+
6	40	0.0008*N*	7.6	7.2	7.2+

Tables 1 and 2 which give the glass electrode and colorimetric pH values of the different water samples show considerable differences between these values, ranging from 0.2 to 0.4 pH units. In all the samples tested, the colorimetric values were lower than the glass electrode values. If the glass electrode were assumed to behave like a hydrogen electrode, the differences in the pH values may be attributed to the salt effect of the indicators used. Apparently contradicting the above results, Burton et al. (4) reported "isohydric" colorimetric pH values of a tap water, and a M/100,000 sodium hydrogen phthalate buffer, which were slightly higher than the glass electrode values. However, details of the colorimetric procedure and salt error corrections were not given.

Corrections for salt errors of phenol red and brom thymol blue, as given by Britton (3) are shown in Table 3. The positive corrections mean that these figures should be added to the colorimetric value for the corresponding salt concentration. Although the salts present in natural waters are not similar to those used in obtaining the corrections in Table 3, the magnitude of the difference found between the two methods is close to the correction corresponding to similar electrolyte concentration.

TABLE 3.—*Corrections for salt errors of indicators at low electrolyte concentration in relation to Clark's buffer solutions.*

Total concentration.	Phenol red.	Brom thymol blue.
0.001*N*	+0.35	+0.19
0.005*N*	+0.28	+0.17
0.01*N*	+0.22	+0.15
0.02*N*	+0.15	+0.12
0.03*N*	+0.09	----------

SUMMARY AND CONCLUSION

It has been shown that the adjustment of indicator solutions for ordinary colorimetric pH measurements in natural waters is not as necessary as has been claimed by some workers. Colorimetric pH values of the Manila water supply were lower than the glass electrode values by 0.2 to 0.4 pH units. This difference may be attributable to the salt error of the indicators used. A preliminary comparison between the colorimetric and electrometric pH values should be considered if reliable colorimetric data is desired. For the purpose of uniformity and comparison, the method used in making pH measurements should be specified.

ACKNOWLEDGMENT

The author is grateful to Mr. A. Magsaysay, Manager of the Metropolitan Water District, Manila, for permission to publish this report; and to Dr. V. G. Lava, for his valuable criticisms and suggestions in the preparation of the paper.

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PHILIPPINE LYMNÆIDÆ AND PLANORBIDÆ

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TWO PLATES

The late L. A. Faustino, in his Summary of the Fresh-water Mollusks of the Philippines (1928), listed under Lymnæidæ only *Amphipeplea cumingiana* Pfeiffer and *Planorbis philippinarum* Dunker. The *Planorbis* species should, however, be stricken from the list, since the name was merely a misspelling by Sowerby [1] of *Planorbis philippianus* Dunker,[2] from Cochabamba, Bolivia. In 1933 Faustino added to the list *Hippeutis umbilicalis* (Benson) and a new species, *Gyraulus prashadi.*

Previous to 1928, however, several other Lymnæidæ and Planorbidæ were recorded from the Philippines. Some of these snails are either known or potential intermediate hosts of worms pathogenic to man or domestic animals.

We have studied rather extensive material from the following sources: The Museum of Comparative Zoölogy, Cambridge, Massachusetts; the Philippine Bureau of Science (through Dr. E. Quisumbing); the School of Hygiene and Public Health of Manila (through Dr. Candido M. Africa); the Academy of Natural Sciences, Philadelphia; Dr. M. Tubangui; and Mr. P. de Mesa. Dr. F. Haas and Dr. A. Zilch have very kindly compared some of our specimens with von Möllendorff's types at the Senckenberg Museum, Frankfort a. M. Dr. Paul Bartsch has sent us paratypes of *Planorbis mindanensis* and *P. mearnsi,* and has given us information regarding the type of *Lymnæa imperialis* Lea.

In order to facilitate the study of these mollusks by local naturalists, we have included all original descriptions, many of which are not available in the Philippines, and we have figured all the species known to us.

LYMNÆIDÆ

Genus LYMNÆA Lamarck, 1799

Lymnæa is the original spelling of the name, which has also been written *Lymnus, Lymnula, Limneus, Lymnæus, Limnea, Limnæa, Limmæus,* and with other variant spellings.

[1] Conch. Icon. 20 (1877) pl. 3, figs. 23*a*, *b*.
[2] Proc. Zoöl. Soc. London (1848) 43.

The two species known from the Philippines belong to the subgenera *Galba* Schrank (1803) and *Radix* Denys de Montfort (1810).

LYMNÆA (GALBA) PHILIPPINENSIS Nevill. Plate 1, fig. 2.

Limnæa philippinensis NEVILL, Journ. Asiat. Soc. Bengal **50** pt. 2 (1881) 142 (Lucban, Luzon).

Limnæus philippinensis (Mousson) CLESSIN, Syst. Conch.-Cab. **1** pt. 17 (1886) 383, pl. 52, fig. 8 (Polillo, Luzon).

Limnæa philippinarum (Nevill) PAETEL, Cat. Conch.-Samml. 2 (1889) 399.

Limnæa (Fossaria) philippinensis v. MÖLLENDORFF, Bericht. Senckenberg. Naturf. Ges. (1893) 104 (Basay near Maasin, Leyte);[3] Nachrichtsbl. d. Mal. Ges. **30** (1898) 11 (Luzon; Leyte; Cebu).

Lymnæa philippinensis DE JESUS, Philip. Journ. Sci. **58** (1935) 302, pl. 1, figs. 1–6 (Luzon, Manila; Pampanga, Bulacan, Laguna, Tayabas, Batangas, Pangasinan, and Rizal Provinces. Samar. Leyte. Cebu. NEGROS, Occidental Negros Province).

LUZON, Laguna Province, Biñan; Maynit; Majayjay; Manila. BOHOL, Bohol Province, Barrio Toog, Vilar. LEYTE, Leyte Province, Santa Fé, Palo; Basay Maasin. CEBU, Cebu Province, Barili.

L. philippinensis is probably distributed throughout the Archipelago. Superficially it resembles the palæarctic *L. truncatula* (Müller) and is quite closely allied to *L. pervia* v. Martens, a widely distributed snail of China and Japan. As Nevill suggested, it is perhaps only a race of *L. pervia.* De Jesus (1935) has shown that it is, in the Philippine Islands, the intermediate host of the cattle liver fluke, *Fasciola hepatica* (Linnæus).

Original description:

Shell scarcely rimate, small, horn coloured, conically globose, longitudinally striate under the lens; spire short, apex rather pointed; whorls four, the upper ones very small, scarcely convex, the last one very large in proportion, tumidly ventricose; aperture ovate, large, proportionately unusually broad, margins joined by a thin callosity, outer margin boldly, convexly rounded; columella straight, very slightly twisted, broadly reflected, rounded at base. Long. 8½, diam. 5½, apert. alt. 5¾, lat. 4 mil. This is a small species of the group of *Limnaea peregra,* closely allied to the next species (*L. andersoniana* Nevill), of which indeed some conchologists may prefer to rank it as a geographical variety. Both perhaps are geographical races, or subspecies, of *L. ollula* Gould, P. B. S. 1869 from Hongkong, sent me from that place and also from Swatow by Surgeon-Major Hungerford, which again = *L. pervia* Martens.—NEVILL, loc. cit.

[3] Reference erroneously credited by de Jesus (1935) to Rehn.

LYMNÆA (RADIX) SWINHOEI var. QUADRASI v. Möllendorff. Plate 1, fig. 1.

Limnæa (*Radix*) *quadrasi* v. MÖLLENDORFF, Nachrichtsbl. d. mal. Ges. **30** (1898) 10 (Lake near Trinidad, Mountain Province, Luzon).

LUZON, Mountain Province, Trinidad Valley. We have also seen one of von Möllendorff's paratypes and have had some of our specimens compared with the holotype and paratypes at Frankfort.

The Philippines *L.* (*R.*) *quadrasi* is perhaps not really separable as a race or variety from typical *L. swinhoei* H. Adams.[4] Comparing Formosan with Philippine specimens, we find that in most typical *L.* (*R.*) *swinhoei* the aperture is more evenly semielliptical in outline, the lip joining the body whorl more at a right angle; while in *L.* (*R.*) *quadrasi* the outline of the the aperture is usually more ovate, with the lip obliquely inserted on the body whorl; but some of the Philippine snails scarcely differ in this respect from those of Formosa. Our largest *L.* (*R.*) *quadrasi* measures in length, 20 mm; greatest width, 12 mm; aperture, 14 by 8 mm.

L. swinhoei itself is, moreover, rather doubtfully distinct specifically from *L. plicatula* Benson, a common snail of China, which in turn is perhaps not more than a race of *L. auricularia* (Linnæus).

Original description:

T. rimata, ovato-acuminata, tenuis, pellucida, plicato-striata, in interstitiis subtilissime striatula, luteo-cornea. Spira brevis, acuta. Anfr. 4½, sat celeriter accrescentes, convexi, ultimus subinflatus, ¾ altitudinis aequans. Apert, parum obliqua, ovalis, peristoma rectum, acutum, basi subeffusum, columella paulum calloso-incrassata, intus spiraliter recedens. Diam. 10.5, alt. 16, apert. lat. 7, long. 11.5 mm.—MÖLLENDORFF, loc cit.

Genus MYXAS Sowerby, 1822

Limnea subg. *Myxas* (Leach) G. B. SOWERBY, Genera Fossil Recent Shells pt. 7 (1822); monotypic for "*Helix glutinosa* Mont. *Limnea glutinosa* Drap." = *Buccinum glutinosum* Müller, 1774.

Amphipeplea NILSSON, 1823, Hist. Moll. Sueciae (1822) 58. Monotypic for *Buccinum glutinosum* Müller, 1774.

Lutea GRAY in Turton, Man. Land Fresh-water Shells Brit. Isl. New ed. (1840) 243. Not of Brown, 1827.

Mixas (Leach) SAY, American Conchology (1832) pl. 31. A misspelling of *Myxas*. Same type.

[4] Proc. Zoöl. Soc. London (1866) 319, pl. 33, fig. 13. Takow, Formosa.

Myxus (Leach) H. and A. ADAMS, Genera Recent Mollusca 2 (1855) 255 (as a synonym of *Amphipeplea*); emendation of *Myxas*. Same type.

Bullastra Bergh in Semper, Reisen Philippinen pt. 4 7 (1901) § 3 Lief. 1 254; monotypic for *Bullastra velutinoides* Bergh, 1901 = *Amphipeplea cumingiana* Pfeiffer, 1845.

Amphipeplia ANTON, Verzeichn. Conch. Samml. (1839) 50; misspelling of *Amphipeplea*. Same type.

Amphipeplaea AGASSIZ, Nomencl. Zoöl. Möll. (1846) 5; emendation of *Amphipeplea*. Same type.

Amphipepla SHERBORN, Index Animal. § 2 pt. 2 (1923) 277; misspelling of *Amphipeplea*. Same type.

MIXAS CUMINGIANA (Pfeiffer). Plate 1, fig. 3.

Amphipeplea cumingiana PFEIFFER, Proc. Zoöl. Soc. London (1845) 68 ("Naga, province of South Camarines," Luzon); KÜSTER, Syst. Conch.-Cab. 1 pt. 17*b* (1863) 59, pl. 10, figs. 18, 19; FAUSTINO, Summary Philippine Marine Fresh-water Mollusca (1928) 355.

Amphipeplea luconica BECK, Index Moll. (1837) 115 (Luzon; *nomen nudum*).

Lymnæa (*Amphipeplea*) *luzonica* SOULEYET, in Voyage de la Bonite Zoöl. 2 (1852) 525, atlas, pl. 29, figs. 33–37 (Manila, Pasig River).

Amphipeplea cumingi NEVILL, Hand List Moll. Indian Mus. 1 (1878) 239 (Luzon).

Amphipeplea quadrasi VON MÖLLENDORFF, Nachrichtsbl. d. malay. Ges. 27 (1895) 119 (in Manila, and Laguna and Pampanga provinces, Luzon; with var. *lamellifera* v. Möllendorff; loc cit., 119; Cebu and Leyte).

Bullastra velutinoides BERGH in Semper, Reisen Philippinen 7 pt. 4, § 3 Lief. 1 (1901) 254, pl. 20, figs. 22–34 (?Philippine Sea); FAUSTINO, Summary Philippine Marine Fresh-water Mollusca (1928) 347.

LUZON, Manila: Albay Province, Albay: Laguna Province, Calamba, San Juan River; Cabuyao, Barrio Dita; Nagcarlang, Palayan: Sorsogon Province, Donsol: Batangas Province, Lipa. MARINDUQUE, Santa Cruz. CEBU. BALABAC.

M. cumingiana appears to be distributed throughout the Archipelago.

Dr. A. Zilch, who compared some of our specimens with a paratype of *A. cumingiana* and with von Möllendorff's types of *A. quadrasi*, writes us that *A. quadrasi* is a synonym of *cumingiana* Pfeiffer. We had reached the same conclusion independently.

Küster (1863) gave *Limnæa imperialis* Lea [5] as a doubtful synonym of *A. cumingiana* Pfeiffer. The figure given somewhat resembles a *Myxas*. Fortunately Lea's type is at the U.

[5] Trans. Amer. Phil. Soc. Philadelphia 5 (1834) 81, pl. 19, fig. 73. "South America"?

S. National Museum (No. 104910), where Doctor Bartsch examined it at our request. He writes us that it is "*Strophocheilus*, probably *ovatus*."

Original description of *A. cumingiana:*

Amph. testa ovato-globosa, tenuissima, longitudinaliter confertim striatula, nitidissima, pellucida, pallide cornea; spira brevissima, mucronulata, callo tenui semi-obtecta; columella nulla; margine anfractuum interno arcuato, appendice membranaceo (deciduo) munito; apertura amplissima, semi-ovali, margine supero breviter arcuato, patente. Long. 30, diam. 22 mill.; apertura 26 mill. longa.—PFEIFFER, loc. cit.

Original description of *L. luzonica:*

Lymnaea, testa ovata, tenui, fragilissima, pallide virescente; spira brevissima, retusa; anfractibus tribus; infimo maximo, convexo; apertura ovato-oblonga, basi angustata; labio inflexo, arcuato; labro acuto, fragilissimo. Coquille ovale trés-mince et très-fragile, translucide, d'un vert olivâtre pâle. Spire très-courte, aplatie, munie de trois tours dont le dernier forme á lui seul presque toute la coquílle. Ouverture ovale-oblongue, rétrécie vers la base; bord interne infléchi et arqué; bord externe tranchant et d'une grande fragilité. . . . Dans les plus grands individus que nous avons recueillis, la coquille avait environ trois centimètres de longueur, et deux centimètres de largeur.

Original description of *A. quadrasi:*

T. subglobosa, tenuis, transverse plicato-striatula, nitens, pellucida, pallide lutescens; spira vix prominula apice mucronato. Anfractus 4 pone suturam profunde impressam obtuse angulati, ultimus superne planiusculus, tum obtuse angulatus, denique tumidus. Apertura parum obliqua, amplissima, peristoma rectum, acutum, margo superus ab insertione paulum ascendens et protractus, columellaris palum incrassatus, vix plicatus. Diam. 20, alt. 27, apert. diam. 16, alt. 23.5 mm.—Var. *lamellifera:* margine columellari fortiter lamellatim incrassato. Diam. 22.5, alt. 30 mm.

—MÖLLENDORFF, loc. cit.

The original description of *B. velutinoides* is mostly based on the anatomy. The shell is described as follows: "Die wegen ihrer Cuticula gelbbraune, sehr dünne Schale hatte eine Länge von 18 bei einer Breite von fast 11 mm.; die von vorne nach hinten verlaufenden Furchen stark, die entblösst liegende Spira ziemlich gross.—BERGH, loc. cit.

PLANORBIDÆ

Genus PLANORBIS O. F. Müller, 1774

This genus is represented in the Philippines only by a South American species, recently introduced through the agency of man.

PLANORBIS (AUSTRALORBIS) LUGUBRIS Wagner. Plate 1, figs. 5 to 7.

Planorbis lugubris WAGNER in Spix, Test. Fluv. Brasil. (1827) 27, pl. 18, figs. 3–6 (Ilheos and Almada, Prov. Bahia, Brazil).

Planorbis albescens SPIX, Test. Fluv. Brasil. (1827) 27, pl. 28, fig. 5 (as a synonym of *P. lugubris*).

Planorbis nigricans SPIX, Test. Fluv. Brasil. (1827) 27, pl. 28, figs. 3, 4 (as a synonym of *P. lugubris*).

Planorbis viridis SPIX, Test. Fluv. Brasil. (1827) 27, pl. 28, fig. 6 (as a synonym of *P. lugubris*).

LUZON, Manila, in an aquarium (*P. de Mesa, 1936*): Batangas Province, Lipa, received from the School of Hygiene and Public Health, Manila.

We owe the identification of these snails as the South American *P. lugubris* to Dr. F. Haas and Dr. A. Zilch, which, on comparison of several lots of *lugubris* from Brazil, agree perfectly with the Philippine snails. All, however, are young shells, the largest seen measuring 12 mm in diameter.

Australorbis was recently proposed as a genus by Pilsbry[6] to replace *Planorbina* Dall, 1905 (*nec* Haldeman, 1843). We prefer to give it subgeneric rank under *Planorbis*.

Original description:

Pl. testa discoidea, tenui, utrinque profunde umbilicata, ferruginea; anfractibus rotundatis, oblique striatis.—Testa discoidea, tenuis, pellucida, striis obliquis numerosissimis, subtilibus instructa; epidermide tenui vestita. Anfractus quatour rotundati, ultimus inflatus, cylindricus; caeteri gyri utrinque aream profunde excavatam formantes, quae tamen in parte inferiore est profundior quam in superiore. Apertura obliqua, margine acuto. Color epidermidis ferugineus; color testae epidermide privatae albus. Longitudo 3½ lin.; lat. 10½ lin.—WAGNER, loc. cit.

Genus ANISUS Studer, 1820

The Philippine species of this genus belong to the subgenus *Gyraulus* J. de Carpentier, 1837.

ANISUS (GYRAULUS) CONVEXIUSCULUS (Hutton). Plate 2, figs. 4 to 6.

Planorbis convexiusculus HUTTON, Journ. Asiatic Soc. Bengal pt. 2 18 (1849) 657 (Candahar; Quettah.; Kojuck Pass; Helmund River at Girishk; all foregoing localities in Afghanistan. Also from Tope Chancey Gangetic Provinces; and Pinjore below Simla); JUTTING, Treubia 13 (1931) 6, figs. 1–4.

Gyraulus convexiusculus ANNANDALE and PRASHAD, Rec. Indian Mus. 18 (1919) 52, figs. 7*b*, 8*b*; RENSCH, Arch. f. Hydrobiol. Suppl.-Bd. 13 (1934) 209.

[6] Proc. Acad. Nat. Sci. Philadelphia 86 (1934) 55.

Planorbis compressus VON MARTENS, Malak. Blätter 14 (1867) 213 (Laguna de Bay, Luzon); MAX WEBER, Zoöl. Ergebn. Reise Niederl. Ost-Indien pt. 1 4 (1897) 13, pl. 1, figs. 17–22; pl. 12, figs. 7, 10 (Java; Celebes). Not of Michaud, 1831, nor of Hutton, 1834.

Planorbis neglectus VAN HASSELT, Algem. Konst en Letterbode (1823) 244 (Java; *nomen nudum*); CLESSIN, Syst. Conch.-Cab. pt. 17 1 (1884) 194, pl. 29, fig. 5 (Macassar; Yokohama).

Planorbis (*Gyraulus*) *demissus* WESTERLUND, Vega-Exped. Vet. Iakttag. 4 (1887) 204, pl. 4, fig. 16 (Pointe de Galle, Ceylon).

Planorbis infralineatus VON MARTENS, Malak. Blätter 14 (1867) 213 (Preanger-Regentschaften near Telaga-Patengan, Java).

Planorbis infracoloratus (von Martens) RENSCH, Arch. f. Hydrobiol. Suppl.-Bd. 13 (1934) 209 (as a synonym of *P. convexiusculus;* error for *infralineatus.*)

Planorbis (*Nautilina*) *javanicus* (Mousson) NEVILLE, Hand List Moll. Indian Mus. 1 (1878) 244 (Java; *nomen nudum*); GERMAIN, Rec. Indian Mus. pt. 3 21 (1923) 140 (as a synonym of *P. infralineatus*).

Planorbis propinquus (Mousson) VON MARTENS, Malak. Blätter 14 (1867) 214 (Buitenzorg, Java; as a synonym of *P. compressus*).

Planorbis sagoensis BULLEN, Proc. Mal. Soc. London pt. 3 7 (1906) 129, fig. (Mount Sago, Sumatra).

Planorbis compressus var. *siamensis* VON MARTENS, Malak. Blätter 14 (1867) 214 (Bangkok, Siam).

Planorbis confusus var. *tigrina* BAVAY and DAUTZENBERG, Journ. Conchyl. 58 (1910) 18 (Tonkin).

Planorbis compressus var. *striatus* BOLLINGER, Revue Suisse Zool. 22 (1914) 572 (Celebes).

Planorbis saigonensis CROSSE and FISCHER, Journ. Conchyl. 11 (1863) 362, pl. 13, fig. 7 (Saigon, Indo-China).

Planorbis saigonensis CLESSIN, Syst. Conch.-Cab. pt. 17 1 (1884) 191, pl. 29, fig. 3.

Planorbis (*Gyraulus*) *saigonensis* GERMAIN, Rec. Indian Mus. pt. 2 21 (1922) 119.

Gyraulus prashadi FAUSTINO, Philip. Journ. Sci. 51 (1933) 575, fig. 1 (San Antonio, Zambales Province, Luzon, type locality; also near Manila); DE JESUS, Philip. Journ. Sci. 58 (1935) 300 (Laguna, Bulacan, and Pampanga Provinces, Luzon).

Planorbis (*Gyraulus*) *mindanensis* BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 83, fig. 1 (Lake Buluan, Rio Grande Valley, Cotabato Province, Mindanao).

LUZON, Manila, Paco: Mountain Province, Trinidad Valley: Rizal Province, San Juan del Monte: Isabela Province: Ilocos Sur Province, Rio del Pueblo de Sinay. MINDANAO, Surigao Province. SIQUIJOR, Oriental Negros Province, Lazi. MARINDUQUE, Boac.

We have also seen paratypes of *G. prashadi* from San Antonio, Zambales Province, Luzon, and of *P. mindanensis* from Lake Buluan, Mindanao.

This appears to be the most common and most widely distributed of the planorbine snails in the Philippines. It is also known from Afghanistan, India, Siam, Indo-China, most of the East Indian Islands (with the exception of Borneo), as far east as Celebes and Buru; and is represented by slight variations in southern China (var. *chinensis* Dunker) and Japan (var. *japonicus* v. Martens).

There has been some divergence of opinion as to the proper name to be applied to this common snail. After careful study we agree with Annandale and Prashad (1919) in calling it *A. convexiusculus* (Hutton).

At the Museum of Comparative Zoölogy there are six specimens received from Benson as *"Planorbis convexiusculus,"* which may have been part of the original lot described by Hutton. Some of these shells agree with Annandale and Prashad's figure in every particular, having the last whorl perfectly rounded; others, however, have the last whorl subcarinate. As Rensch (1934) has pointed out, the body whorl may be perfectly rounded off or more or less carinate, even in the same lot.

We have not been able to compare specimens of *P. euphraticus* Mousson, from Mesopotamia. We doubt, however, that *Planorbis compressus* Hutton,[7] based upon his *Planorbis* No. 12 [8] from the Ganges River, India, not *P. compressus* Michaud, 1831, is specifically distinct from *A. convexiusculus.* No reliable differences can be pointed out from the description, and the species was based originally upon snails from the Ganges River (not northern India nor Quettah). Annandale and Prashad did not see Hutton's types.

We have carefully compared the type lot of *G. prashadi,* sent by the Philippine Bureau of Science, as well as paratypes of *P. mindanensis,* received from Doctor Bartsch, with various lots of *G. convexiusculus,* from India, Indo-China, and Java, and we are unable to separate the snails from the Philippines, either as a species or as a race. The figures of *prashadi* are rather misleading, as may be seen by comparing our photographs of the paratypes. *A. convexiusculus* is variable even in the same

[7] Journn. Asiatic Soc. Bengal 3 (1834) 93.
[8] Tom. cit. 91.

lot, particularly in the contour of the body whorl (which may be evenly rounded or more or less compressed) and in the shape of the aperture.

Original description of *P. convexiusculus:*

Animal black or dusky. Shell depressed, ¼ of an inch in diameter; pale horn colour; polished; closely and obliquely striate; whorls 4 or 5; rounded; suture well defined; periphery subangular, but not influencing the aperture, which is ovato-lunate; umbilicus wide, discovering all the previous volutions; the whorls rising gradually and spirally from the horizontal, and rounded below.—HUTTON, loc. cit.

Original description of *P. saigonensis:*

T. late, sed non profunde umbilicata, discoidea, tenuis, pellucida, cornea; vertice immerso; sutura profunda; anfr. 3 utrinque convexi, apertura fere horizontalis, ovato-rotunda; perist. acutum, marginibus callo tenui junctis.—Diam. maj. 4½, min. 4, alt. 1½ millim.—CROSSE and FISCHER, loc. cit.

Original description of *G. prashadi:*

Shell discoidal, small, thin, somewhat flat, transparent or translucent, whorls five, rounded, closely and obliquely striated, periphery subangular, spire depressed, aperture egg-shaped. A few of the specimens are black due to habitat. Height, 1 mm.; maximum diameter, 5 mm. This species differs from *G. convexiusculus* (Hutton), which it closely resembles, in having more whorls; and in the shape of the mouth, which is more oviform. It differs from *G. euphraticus* Mousson in being more convex and in having the whorls more rounded, in having an egg-shaped aperture and in having the angle on the middle of the outer lip more pronounced but more like that of *G. convexiusculus.*—FAUSTINO, loc. cit.

Type at National Museum of Philippine Bureau of Science, Manila.

Original description of *P. mindanensis:*

Shell lenticular, biconcave, thin, semitransparent, corneous. Upper surface decidedly more concave than the lower, showing all the whorls which increase evenly and rapidly in size. The entire upper surface is marked by numerous, quite prominent, irregularly developed lines of growth. Periphery of the last whorl marked by a slender keel. The basal parts of the whorls are a little more convex than the upper sides, with the incremental lines less strongly developed. The center of the base is only slightly depressed below the plane of the last whorl; in fact the most convex part of all of the whorls on the base falls almost in an even plane. The turns are separated above and below by well-impressed sutures. Aperture quite large, suboval, decidedly oblique, angulated at the middle of the outer lip by the slender keel. Columella practically absent; parietal wall covered with a thin callus. The type has four and one-fourth whorls and measures: Greater diameter, 6.7 mm.; lesser diameter, 5.7 mm.; altitude, 1.7 mm.—BARTSCH, loc. cit.

Type at United States National Museum.

ANISUS (GYRAULUS) QUADRASI (v. Möllendorff). Plate 2, figs. 7 to 9.

Planorbis (*Gyraulus*) *quadrasi* VON MÖLLENDORFF, Bericht. Senckenberg. Naturf. Ges. (1893) 105, pl. 3, figs. 11, 11*a–c* (Montalban, LUZON, type locality; Leyte); BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 83.

LUZON, Rizal Province, Montalban, paratypes (Philippine Bureau of Science), San Juan River. MINDORO, Mindoro Province, Naujan.

Some of the specimens from San Juan River were compared by Dr. F. Haas and Dr. A. Zilch with v. Möllendorff's types at the Senckenberg Museum, in Frankfort on the Main.

This species differs rather markedly from *A. convexiusculus* in the rapidly enlarged whorls and the number of whorls for the small size. In all specimens seen the last whorl is rounded, without any trace of carina.

Original description:

T. discoidea, subcompressa, utrimque subaequaliter leviter impressa, tenuis, leviter arcuatim striatula, pallide virescenti-flavida, subnitens. Anfr. 3 rapide accrescentes, convexiusculi, sutura sat profunda discreti, ultimus ad peripheriam bene rotundatus. Apertura diagonalis, ovalis, sat excisa; peristoma simplex, acutum, intus callo latiusculo, albo, parallelo munitum.—Diam. maj. 3.5, alt. 1 mm.—Dieser kleine *Gyraulus* steht durch die geringe Zahl der Windungen und die Dimensionen dem *Pl. heudei* Cless. von Hong-kong, Süd-China und Hainan am nächsten, unterscheidet sich aber dadurch, dass die Schale oben und unten etwa gleichmässig vertieft ist, während bei *Pl. heudei* die Unterseite eine stärkere Aushöhlung zeigt. Auch hat die Peripherie keine Spur von Kante, und die Mündung ist weniger schief.—VON MÖLLENDORFF, loc cit.

Type at Senckenberg-Museum, Frankfort on the Main.

Genus HIPPEUTIS Charpentier, 1837

HIPPEUTIS UMBILICALIS (Benson). Plate 1, figs. 8 to 10; Plate 2, figs. 10 to 12.

Planorbis umbilicalis BENSON, Journ. Asiatic Soc. Bengal 5 (59) (1836) 741 (probably Sylhet, India).

Hippeutis umbilicalis FAUSTINO, Philip. Journ. Sci. 51 (1933) 577, fig. 2 (San Antonio, Zambales Province, Luzon; Sitio Napayacan, Buguey, Cagayan Province, Luzon).

Segmentina umbilicalis GERMAIN, Rec. Indian Mus. pt. 3 21 (1923) 176, pl. 2, figs. 19–21 (type from Sylhet).

Planorbis dorrianus WATTEBLED, Journ. Conchyl. 32 (1884) 126, pl. 6, fig. 2 (Long-Xuyen, Cochin-China).

Planorbis dorri (Wattebled) GERMAIN, Rec. Indian Mus. pt. 3 21 (1923) 178.

Planorbis (*Helicorbis*) *mearnsi* BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 84, fig. 2 (Lake Buluan, Rio Grande Valley, Cotabato Province, Mindanao).

LUZON, Cagayan Province, Buguey, Sitio Napayacan: Zambales Province, San Antonio. MINDANAO, Surigao Province. BOHOL, Bohol Province, Vilar, Lagunita del Sitio Mayapo.

We have also seen a paratype of *P. mearnsi* from Lake Buluan, Mindanao.

We have compared our Philippine lots with specimens of *umbilicalis* from Tonkin and can find no consistent or reliable difference, even of subspecific or racial value. We figure specimens from Tonkin, as well as a paratype of *mearnsi* from the Philippines. Germain claims that this species should be placed in *Segmentina;* he was unable to find the inner laminæ or barriers, characteristic of the genus, but surmises that they were resorbed. In the many specimens, of all ages, examined by us, there was never a trace of laminæ. We agree with Bavay and Dautzenberg [9] that *umbilicalis* is a *Hippeutis.*

Original description of *P. umbilicalis:*

Testa quasi dextra luteo-cornea, polita, leviter radiato-striata, infra excavato-depressa, anfractibus omnibus versus umbilicum profundum spectantibus, ultimo interiores pene tegente; supra convexa, versus apicem planata, apice concavo, omnibus anfractibus satis apparentibus: periphaeria obtuse angulata. Diam. 0.3 poll.—This shell belonging to the same division of *Planorbis* as the British species *Pl. fontanus* (*Pl. nitidus* Lamarck) in which the whorls on the inferior side are nearly covered by the succeeding ones, may easily be distinguished from that species, which it resembles also in colour, by the greater convexity of the last whorl towards the periphery, and by the slope towards the penultimate whorl, on the under side; while in *Pl. fontanus* the convexity is next to the penultimate whorl, and the slope tends toward the circumference. The disposition observed in *Pl. umbilicalis* occasions a great concavity on the under side of the shell. The superior margin of the aperture, as in most of the depressed Planorbes, projects much behind the inferior margin, occasioning a great obliquity from the plane of the axis. The North American species *Pl. deflexus* and *Pl. exacuens* of Say, more especially the latter, have an affinity to this shell, which is probably an inhabitant of the streams of silhet.—BENSON, loc. cit.

Original description of *P. mearnsi:*

Shell lenticular, vitreous, horn color. Whorls increasing regularly in size, the last enveloping the greater part of the previous turns. All of the whorls show evenly coiled on the dorsal surface in the extremely regularly conically depressed apex. The last half turn only, deviates from the regular spiral in having the summit gradually deflected until it falls about halfway between the summit and periphery on the preceding turn, at the aperture. The angle at the junction of the outer wall and the parietal wall is filled up for a short distance, and this shows through the

[9] Journn. Conchyl. 58 (1910) 19.

shell as a moderately broad solid band, and makes the whorls appear as if they had a double suture. The whorls are evenly rounded on the dorsal surface and marked by moderately strong incremental lines only. Sutures lightly impressed. Periphery of the last whorl bluntly but strongly angulated. Base almost flat, with a moderately broad umbilicus, in which the whorls can be seen regularly and evenly coiled, but here also the last half of the last one becomes more and more openly coiled until it reaches a point at the aperture, about one-third of the distance toward the periphery from the umbilicus to the periphery. The base, like the upper surface, is marked by numerous incremental lines. Aperture decidedly oblique, arrow shaped, the apex falling at the periphery, and the two barbs above and below the periphery of the preceding turn. Outer lip thin, somewhat sinuous; basal lip almost straight; columella exceedingly short, represented by the mere upward turn of the basal lip; parietal wall covered by a thin callus. The type has almost five whorls and measures: Altitude 1.5 mm.; greater diameter, 5 mm.; lesser diameter, 4.4 mm. The only other *Helicorbis* reported from the islands is *P.* (*H.*) *luzonicus* Möllendorff. The much larger size—altitude, 3 mm.; greater diameter, 10.5 mm.; lesser diameter, 9 mm.—is sufficient to distinguish it from the present species.

—BARTSCH, loc. cit.

Type at United States National Museum.

HIPPEUTIS LUZONICUS (V. Möllendorff).

Planorbis (*Hippeutis*) *luzonicus* VON MÖLLENDORFF, Nachrichtsbl. d. Malay. Ges. 27 (1895) 120 (near Libmánan in Camarines Province, Luzon).

Planorbis (*Helicorbis*) *luzonicus* BARTSCH, Proc. U. S. Nat. Mus. 32 (1907) 84.

Original description:

T. late et aperte umbilicata, discoidea, solidula, subpellucida, sat distincte striatula, corneo-lutea; spira plana. Anfr. 5 lente accrescentes, sutura distincte marginata, profunda discreti, convexiusculi, ultimus basin versus sat acute angulatus, basi fere planus. Apertura diagonalis, lanceolata, peristoma rectum, acutum. Diam. maj. 10.5, min. 9; alt. 3 mm.

—V. MÖLLENDORFF, loc. cit.

Type at Senckenberg Museum, Frankfort on the Main.

The species is unknown to us.

Genus BULINUS O. F. Müller, 1774

For a recent discussion of this genus see Pilsbry and Bequaert [10] and F. Hass.[11] As pointed out by B. Prashad [12] the

[10] Bull. Amer. Mus. Nat. Hist. 53 (1927) 132.

[11] Arch. f. Naturg., N. F. pt. 2 4 (1935) 230; Abh. Senckenberg. Naturf. Ges. Abh. 431 (1936) 26.

[12] Rec. Indian Mus. 22 (1921) 475.

species of the Malayan Archipelago differ markedly from the African forms, placed in *Bulinus* proper (*Isidora* Ehrenberg), in being more elongate, with distinctly produced spire and a well-marked fold along much of the columella. They may be conveniently grouped in a distinct subgenus, *Physastra* Tapparone-Canefri.[13] The group is known from Sumatra, the Philippines, Celebes, Amboina, Timor, New Guinea, New Caledonia, and some of the other Pacific Islands, and Australia and New Zealand. Whether *Pulmobranchia* Pelseneer, based upon a species from Madagascar, is a synonym of *Physastra* (as Thiele states) is open to question.

Two species from the Philippines were referred to *Ameria* H. Adams.[14] This name should be applied to a subgenus of *Bulinus*, characterized by the low or somewhat depressed spire and the presence of a spiral carina or shoulder on the body whorl. Of the two Philippine species, *A. quadrasi* v. Möllendorff is said to have the whorls convex and subcanaliculate at the suture, and consequently appears to be a *Physastra*. *A. hidalgoi* Quadras and v. Möllendorff, described as having the whorls "rather sharply carinate above the middle," may be a true *Ameria*.

BULINUS (PHYSASTRA) HUNGERFORDIANUS (Nevill). Plate 1, fig. 4.

Physa hungerfordiana NEVILL, Journ. Asiat. Soc. Bengal pt. 2 **50** (1881) 143 (Lucban, Luzon).

Physa semperi CLESSIN, Syst. Conch.-Cab. pt. 17 **1** (1886) 348, pl. 49, fig. 6 (Mancayan, Philippines).

LUZON, Manila: Laguna Province, Laguna Bay, Santa Cruz; Calamba, San Juan River; Cabuyao: Rizal Province, Alabang River, Muntinglupa River; Antipolo. MINDANAO, Cotabato Province, Malabán. PANAY.

The species is probably widely distributed throughout the Archipelago. We have seen several lots provided by v. Möllendorff with two manuscript varietal names ("slightly ventrose," "convex"), but are unable to separate them from the typical form.

The many lots of *Bulinus* we have seen from the Philippines belong to this one species.

Original description of *Physa hungerfordiana:*

[13] Ann. Mus. Civ. Stor. Nat. Geneva **19** (1883) 245; type: *Physastra vestita* Tapparone-Canefri, of New Guinea.

[14] Proc. Zoöl. Soc. London (1861) 143; type: *Physa (Ameria) carinata* H. Adams, of Australia.

Shell convexly ovate, imperforate, moderately thick, scarcely transparent, somewhat obsoletely striate, striæ close, regular, slightly flexuous; yellowish brown, generally covered with a dark coloured deposit; spire turretly produced, suture excavated, apex somewhat obtuse; whorls 3½, increasing rapidly, convexly swollen; aperture narrowly produced, as broad above as below, outer margin gradually rounded; columella somewhat reflected or thickened, twisted, bent a little backwards at base. Long. 13½ to 14½, diam. 7½; apert. alt. 8, lat. 4 mil. The only other Philippine, or indeed Malayan, species except *Ph. moluccensis* Lesson, is *Ph. philippina* Martens, Malak. Blät. 1867; long. 19, diam. 12 mil. Küster's Pl. I, figs. 18–20, will give a rough idea of the general shape of *Ph. hungerfordiana*. —NEVILL, loc. cit.

The present location of the type is unknown.

Original description of *Physa semperi:*

Testa elongato-ovata, levissime rimata, leviter striata, tenuis, fuscocornea; spira elongata, obtusa; anfr. 5, celeriter accrescentes, valde convexi, sutura profunda separati; ultimus parum elongatus, fere dimidiam partem longitudinis aequans; apertura anguste-ovata; peristoma acutum, tenue, marginibus callo columellari tenui conjunctis; columella tenuis, modice contorta. Lg. 16.5 mm.; diam. 7 mm. Gehäuse: verlängert-eiförmig, sehr fein geritzt, fein gestreift, dünnschalig, bräunlich-hornfarben; Gewinde verlängert, stumpf; Umgänge 5, rasch zunehmend, sehr gewölbt, durch tiefe Naht getrennt; der letzte etwas verlängert, fast die Hälfte der Gehäuselänge erreichend; Mündung schmal-eiförmig; Mundsaum dünn, scharf; Ränder durch sehr feine Spindelschwiele verbunden; Spindel dünn, weisslich, mässig gedreht, unten nach rechts gebogen.—CLESSIN, loc. cit.

The type is at the Berlin Museum.

BULINUS (PHYSASTRA) QUADRASI (v. Möllendorff).

Ameria quadrasi VON MÖLLENDORFF, Nachrichtsbl. d. mal. Ges. 27 (1895) 119 (Lake Mainit in Mindanao).

Original description:

T. sinistrorsa, vix rimata, oblonga, tenuis, subpellucida, leviter striatula, lineis spiralibus confertis undique decussata, pallide straminea, plerumque taeniis angustis, castaneis plus minusve numerosis picta. Anfr. 3½–4 (apice plerumque eroso) convexi, rapide accrescentes, sutura valde impressa, subcanaliculata disjuncti. Apert. parum obliqua, oblonge ovalis, superne et inferne acuminata, peristoma rectum, acutum, margine columellari paulum dilatato, callo sat lato apresso. Diam. 8.5, alt. 19.5, apert. diam. 4.5, long 12 mm.—v. MÖLLENDORFF, loc. cit.

Type at Senckenberg Museum, Frankfort a. M.

We have not seen this species, which, to judge from the description, may have been based on large specimens of *B. hungerfordianus*.

BULINUS (PHYSASTRA) PHILIPPINUS (v. Martens).

Physa philippina E. v. MARTENS, Malak. Blätter 14 (1867) 219 (Bosoboso *near* Manila, Luzon); CLESSIN, Syst. Conch.-Cab pt. 17 1 (1886) 348, pl. 49, fig. 4.

Original description:

Testa elliptica, striata, fusca; anfr. vix 4, spiram brevem obtusam efficientes, infra suturam ventricosi, dein planiores; apertura subverticalis, ovata, basi levite effusa, margine externo superne sinuatim recedente; columella incrassata, spiratim torta, nitide alba, dentem simulante. Long. 19, diam. maj. 12, min. 9½, apert. long. 14, lat. 8 mill.—v. MARTENS, loc. cit.

Type at Berlin Museum.

According to Dr. A. Zilch (*in litt.*) the paratypes at the Senckenberg Museum, Frankfort on the Main, are quite distinct from our specimens of *B. hungerfordianus*. The spire is much more obtuse and the body whorl more swollen. The types were collected by v. Martens himself. It seems strange that later collectors have not found the species in the vicinity of Manila.

BULINUS (AMERIA) HIDALGOI (Quadras and v. Möllendorff).

Ameria hidalgoi QUADRAS and v. MÖLLENDORFF, Nachrichtsbl. d. malay. Ges. 27 (1895) 120 (Lake Mainit in Mindanao).

Original description:

T. sinistrorsa, imperforata, ovato-conica, solidula, transverse striatula et sulcis confertis spiralibus exarata, unicolor brunnea aut lutescenticornea taeniis latiusculis castaneis ornata. Anfr. 4 modice convexi, supra medium sat acute carinati, infra carinam spiraliter impressi. Apertura parum obliqua, supiriformis, peristoma rectum, acutum, columella valde calloso-incrassata, subtorta, intus superne subdentata. Diam. 5, alt. 9, apert. long. 5.5, lat. 3 mm.—QUADRAS and v. MÖLLENDORFF, loc. cit.

Type at Senckenberg Museum, Frankfort on the Main.

From the statement that the whorls are rather acutely carinate above the middle this snail appeals to be a true *Ameria*, not a *Bulinus*. Unfortunately we have not seen specimens.

ILLUSTRATIONS

Plate 1

Plate 2

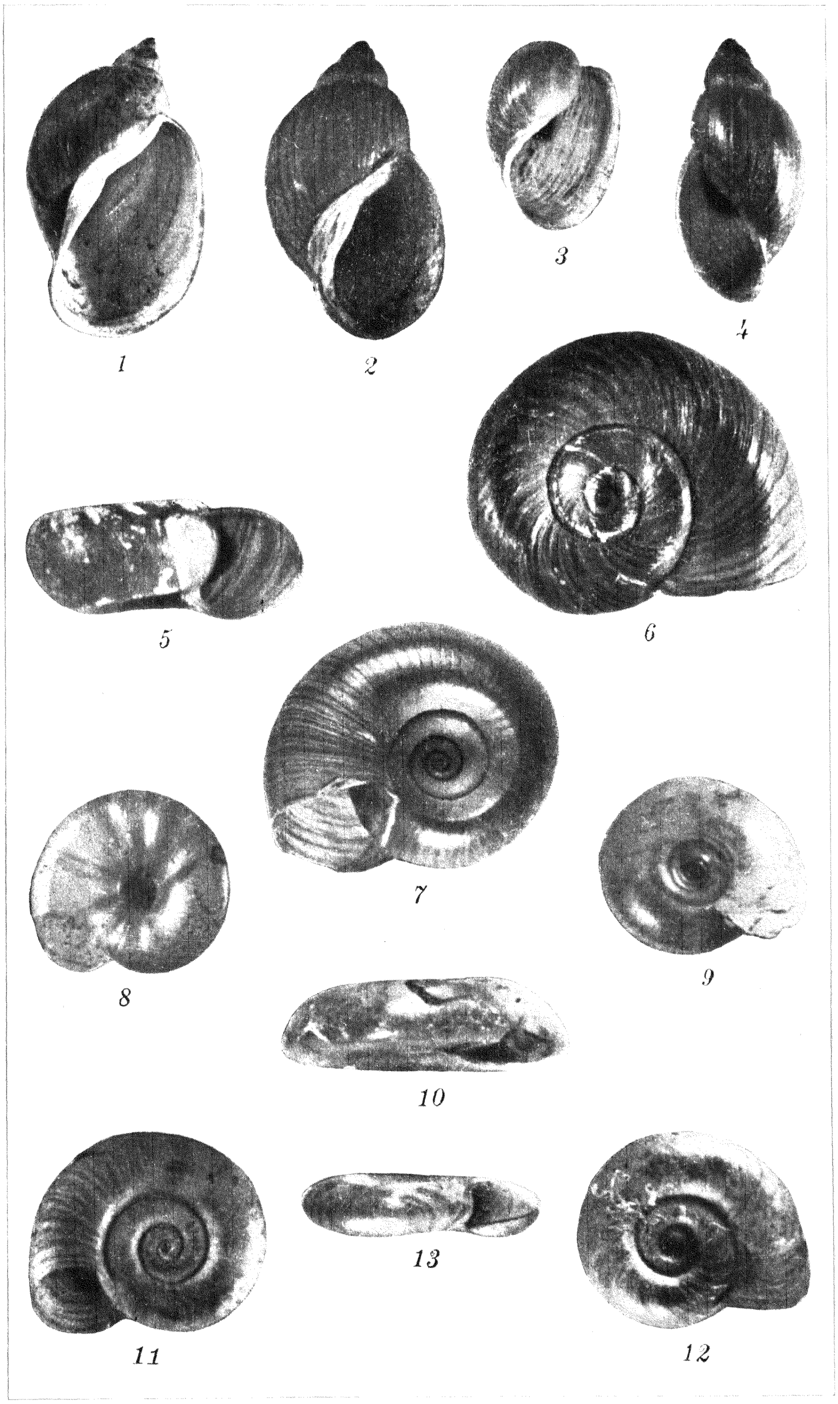

PLATE 1.

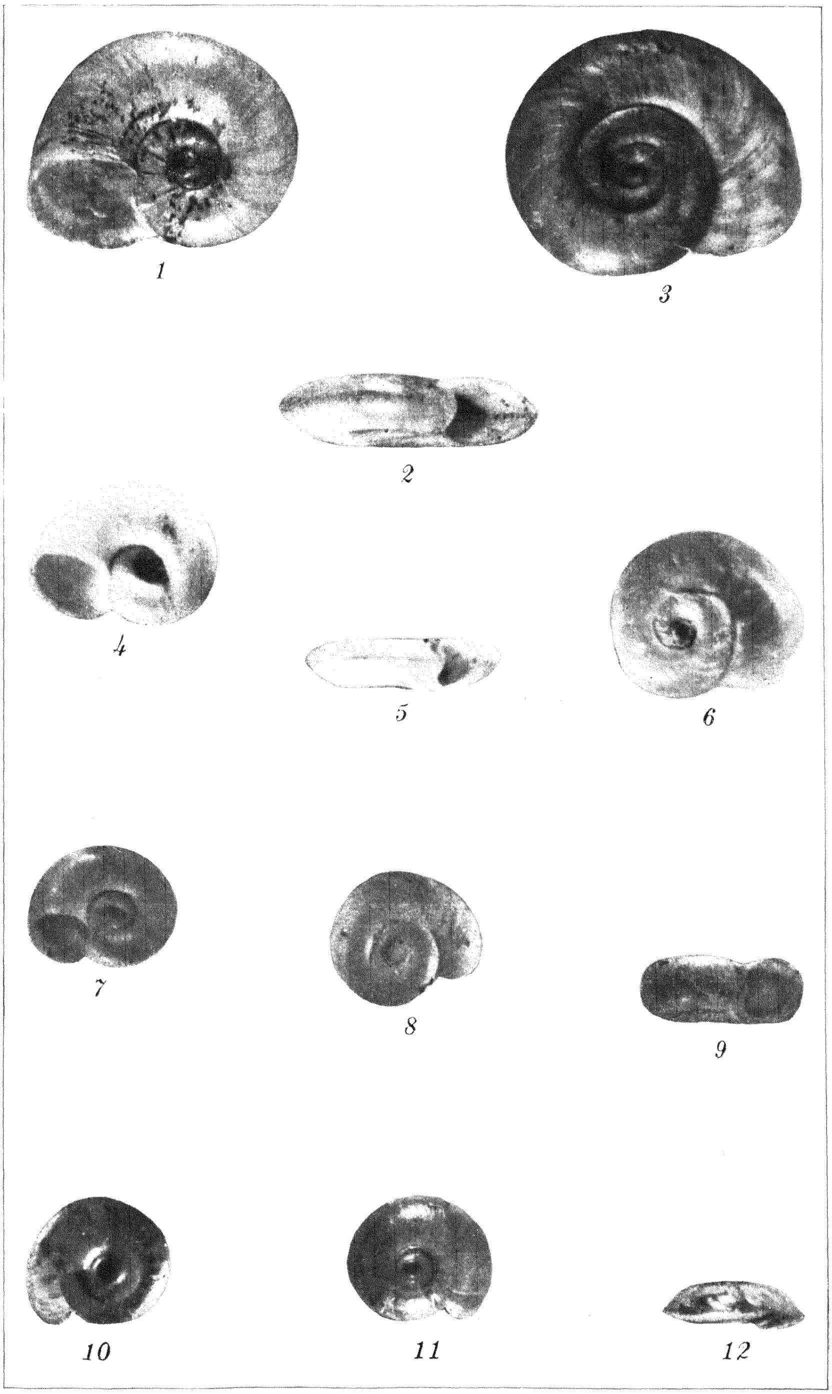

PLATE 2.

ADDITIONS TO THE APHID FAUNA OF FORMOSA (HEMIPTERA), V[1]

By RYOICHI TAKAHASHI

Of the Department of Agriculture, Government Research Institute, Formosa

THREE TEXT FIGURES

MATSUMURAJA RUBIFOLIÆ Takahashi var. **TAIHEISANA** var. nov. Text fig. 1.

Wingless viviparous female.—Yellow. Head small, slightly convex at middle of front, with many granules on dorsum except on large median area, and with capitate setæ, of which four on posterior part are much shorter. Antennæ dusky on apices of segments three to five and on distal area of basal part of segment six, segment three without sensoria, with about ten minute setæ, very slightly striate; segments three to five somewhat constricted near the tip; relative lengths of segments about as follows: III—46, IV—35, V—37, VI—24+94. Rostrum reaching middle coxæ, distal segment twice as long as wide, nearly as long as penultimate, tapering, with three pairs of long setæ. Thorax and abdomen with granules on dorsum. Pronotum with a pair of capitate setæ near anterior margin and a similar, but a little longer, seta on each side; mesonotum with a pair of very short capitate setæ near hind margin and two similar longer setæ on each side; basal seven abdominal segments with a very short capitate seta on each side; abdominal segments four to six with a pair of capitate setæ at middle of dorsum; segment seven with four longer capitate setæ on dorsum; segmen eight with four very long simple setæ in a row on dorsum and a very short simple seta on each side; dorsal capitate setæ variable in length. Cornicles slightly dusky on tip, very slightly swollen near apex, roughly imbricated except on swollen part, as long as width of head including eyes, longer than antennal segment three. Cauda stout, pale. Tibiæ slender, slightly stouter than antennal segment three, with many setæ, of which those on lateral side are capitate and shorter than diameter of tibia; tarsi imbricated, with a median stiff seta and two

[1] Part IV was published in the Philip. Journ. Sci. 63 (1937) 1–19.

much longer lateral setæ on basal segment in fore and middle pairs, but with only two long setæ on it in hind pair. Length of body, 1.7 millimeters; width of head including eyes, 0.32; length of antenna, 1.2; length of antennal segment three, 0.217, width at middle, 0.023; length of cornicle, 0.32; length of hind tibia, 0.65, width at middle, 0.028; length of hind tarsus, 0.097; dorsal seta on pronotum, 0.023 to 0.026; capitate seta on seventh abdominal tergite, 0.051 to 0.055; distance between cornicles, 0.37.

Host.—*Rubus* sp.

Habitat.—Shin-Taiheizan, altitude about 6,000 feet, Rato-gun, Taihoku Prefecture.

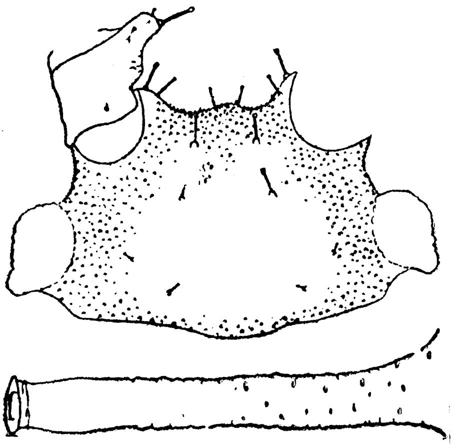

FIG. 1. *Matsumuraja rubifoliæ* Takahashi var. *taiheisana* var. nov.; wingless viviparous female. Head and cornicle.

Two specimens were taken by me October 14, 1937. The present variety differs from the typical form as follows: Dorsal capitate setæ on posterior part of head shorter. Tubercle on base antennal segment a little shorter. Thorax with fewer shorter setæ. Basal abdominal segments with shorter setæ on side and fewer shorter setæ on median area of dorsum. Dorsal setæ on abdominal segment eight simple, not capitate. In typical form meso- and metanotum and basal abdominal segments with four capitate setæ in a row on the median area of dorsum.

AULACORTHUM SOLANI Kaltenbach.

Acyrthosiphon pisi TAKAHASHI (part), Aphididæ of Formosa, VI. Dept. Agr. Res. Inst. Formosa Rept. 53 (1931) 63.

Host.—*Myrica rubra.*

Habitat.—Tattaka, Taichu Prefecture.

Some apterous forms were taken by me May 17, 1924, which agree well with the European specimens sent me by Dr. Hille Ris Lambers, though the dorsal setæ on the head are a little thinner in the Formosan material.

Acyrthosiphon pisi Kaltenbach was recorded by Dr. M. Maki from Formosa, but has not been collected by me in that island.

Most of the species recorded by me under the genus *Acyrthosiphon* Mordvilko must be included in the genus *Aulacorthum* Mordvilko, which differs from the former genus in possessing numerous granules on the head.

Aulacorthum kawanai Takahashi (syn. *Acyrthosiphon kuwanai* Takahashi) is closely allied to *A. solani* Kaltenbach, but is different from the latter in the longer dorsal setæ on the head, the darker cornicles, the distal segment of rostrum being about 2.7 times as long as wide, and in other characters. It attacks *Vitis* sp. and *Celtis formosana* in the mountainous regions of Formosa, and sometimes possesses three pairs of setæ on the cauda.

CEROSIPHA sp.

Wingless viviparous female.—Greenish yellow. Cornicles a little dusky on apex. Cauda pale. Antennæ and legs pale, slightly dusky on apices. Head a little convex on middle of front, with two pairs of moderate setæ between eyes, and a pair of slightly longer setæ between antennæ on dorsum, a curved seta on ental side of each frontal tubercle, and with a pair of long curved setæ on front, those between antennæ much shorter than antennal segment two. Frontal tubercles not developed, slightly convex on ental side. Eyes with ocular tubercles. Antennæ slender, imbricated, 5-segmented; segment three lacking sensoria, with about four small setæ which are blunt at tip and shorter than width of segment; relative lengths of segments about as follows: III—50, IV—22, V—27+60. Rostrum nearly reaching hind coxæ; distal segment a little more than twice as long as wide, a little tapering, blunt at apex, slightly longer than penultimate segment, with three pairs of long fine setæ. Prothorax and abdominal segments one and seven with a small lateral tubercle; tubercles on prothorax and abdominal segment one a little larger, longer than wide, tapering. Abdominal segment not corrugated, with a few curved dorsal setæ in a row, these setæ blunt apically and as long as those on head between antennæ. Cornicles cylindrical, a little broadened towards base, sometimes a little constricted near distal part, somewhat imbricated except on distal part, shorter than width of head, about three and one-half or four times as long as wide, a little shorter than antennal segment three, about twice as long as, or a little longer than, cauda. Cauda rather stout, not distinctly constricted, blunt at tip, distinctly longer than wide, with two pairs of curved lateral setæ. Legs slender; coxæ with about

six very long fine curved setæ; trochanters with two similar setæ; tibiæ with many stiff setæ, some of which are as long as width of tibiæ; tarsi striate, with a median stiff seta and two lateral slightly or scarcely longer setæ on basal segment in fore and middle pairs. Length of body, about 1 millimeter; width of head including eyes, about 0.28; length of antenna, 0.78; width of antennal segment three at middle, 0.018; length of cornicle 0.18, width at tip, 0.032; length of hind tibia, 0.47, width at middle, 0.023; length of hind tarsus, 0.06; dorsal seta on head between antenna, 0.019 to 0.024.

Host.—A species of the Urticaceæ, on nether surface of young leaf.

Habitats.—Kayahara, Shinchiku Prefecture; Hatonosawa, near Taiheizan, Taihoku Prefecture.

A few apterous females were collected by me August 1, 1933, at Kayahara, and October 14, 1937, at Hatonosawa. New to the fauna of Formosa. This species may be hitherto undescribed, but I hesitate to give a new name to it, since the winged form is not known and comparison with other species of the genus and the related groups is not possible.

Genus CRANAPHIS novum

Winged viviparous female.—Body without prominent setæ. Head with a short conical tubercle on front above anterior ocellus. Frontal tubercles absent. Eyes with distinct ocular tubercles. Antennæ long, 6-segmented, lacking prominent setæ, with oval sensoria on segment three; distal part of last segment nearly as long as basal part. Rostrum very short. Cornicles very short, much wider than long. Cauda knobbed. Anal plate deeply bilobed, lobes parallel. Media on forewings twice branched, hind wings with media and cubitus present. Trochanters defined from femora; tibiæ with microtrichiæ and distal part and spines at tip; tarsi with some setæ on basal segment; empodial setæ flattened.

Genotype.—*Monellia formosana* Takahashi.

Differs from *Monellia* Oestlund in the shape of head, and from *Myzocallis* Passerini in the very short cornicles and in the presence of a conical tubercle on the front of head. In *Monellia* the head has no distinct median tubercle on the front.

CRANAPHIS FORMOSANUS Takahashi.

Myzocallis formosanus TAKAHASHI, Aphididæ of Formosa, III. Dept. Agr. Res. Inst. Formosa Rept. 10 (1924) 64; Proc. Ent. Soc. Washington 28 (1926) 160.

Monellia formosana TAKAHASHI, Trans. Nat. Hist. Soc. Formosa 19 (1929) 259; Aphididæ of Formosa, VI. Dept. Agr. Res. Inst. Formosa Rept. 53 (1931) 81.

Host.—*Arundinaria niitakayamensis.*

Habitats.—Arisan; Taiheizan, Taihoku Prefecture; Hassenzan, Taichu Prefecture; Hattsukan near Mount Niitaka (Mount Morrison).

Widely distributed on high mountains, occurring, however, in restricted numbers.

CERATOVACUNA ORIENTALIS Takahashi.

Oregma orientalis TAKAHASHI, Aphididæ of Formosa, II. Dept. Agr. Res. Inst. Formosa Rept. 4 (1923) 52, 144.

Ceratovacuna orientalis TAKAHASHI, Aphididæ of Formosa, VI. Dept. Agr. Res. Inst. Formosa Rept. 53 (1931) 95.

Winged viviparous female.—Horns on head long, slender, sharply pointed, as long as antennal segment two, a little divergent. Antennal segment three a little longer than segments four and five together, with thirty to thirty-three narrow sensoria in a row; segment four nearly as long as segment five, with thirteen sensoria; segment five with ten or eleven sensoria; relative lengths of segments about as follows: III—68, IV—27, V+29. Abdomen sclerotized on last two tergites. Cornicles small, not fringed with setæ, with a narrow sclerotized border at base. Fore and middle tarsi with a stout median seta and two much longer lateral setæ on basal segment; hind tarsi bearing only two very long fine setæ. Length of body, 2 millimeters; horn on head, 0.046; antenna, 0.68, width of antennal segment three, including sensoria, 0.046; diameter of cornicle at apex, including margin, 0.046; width of cauda, 0.088.

Host.—*Oplismenus* sp.

Habitat.—Piyahau, Suo-gun, Taihoku Prefecture.

A few winged forms, which have not been described hitherto, were taken by me October 16, 1937. This species is widely distributed in Formosa, and is characterized by the long horns on the front of head of the winged form.

CERATAPHIS BAMBUSIFOLIÆ Takahashi. Text fig. 2.

Cerataphis bambusifoliæ TAKAHASHI, Aphididæ of Formosa, IV. Dept. Agr. Res. Inst. Formosa Rept. 16 (1925) 50; VI, ibid. 53 (1931) 100; Lingnan Sci. Journ. 9 (1930) 11.

Winged viviparous female.—Head on dorsum with two pairs of small simple setæ on hind part, four similar setæ in a row anterior to dorsal ocelli, and two short setæ near each antennna.

Front with a pair of small thin spinelike setæ, which are much narrowed and flagellate on distal part, constricted at base, not reaching apex of front ocellus. Eyes large, with distinct ocular tubercles. Front ocellus protruding, as large in diameter as dorsal ocelli. Antennæ 5-segmented; segment one with about three simple fine setæ in a row near apex on ventral side; segment three slightly longer than segments four and five together, with a rather long seta, and twenty-six to thirty-four sensoria, which occupy much over half circumference of segment; segment four slightly narrowed towards base, slightly shorter than segment five, with nine to thirteen similar sensoria and a protruding primary sensorium at apex; segment five with ten to twelve sensoria and a rather small primary sensorium; relative lengths of segments about as follows: III—80, IV—35, V—40.

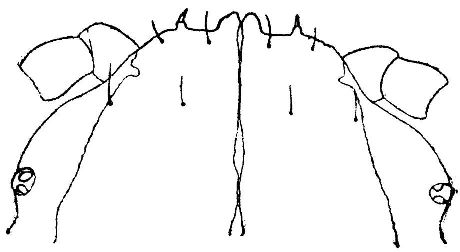

FIG. 2. *Cerataphis bambusifoliæ* Takahashi; grown nymph of winged form. Head.

Rostrum stout, not reaching middle coxæ, distal segment slightly longer than wide, smaller than penultimate segment, blunt apically. Abdomen with a few rather short simple setæ. Cornicles very short, on a circular sclerotized area, beset with four setæ. Cauda knobbed, knob much wider than long, slightly narrower than anal lobes, with about sixteen setæ. Anal plate bilobed but not separated, rather large, with about sixteen setæ on each lobe. Legs with some simple setæ; trochanters fused with femora; tibiæ narrower than antennal segment three, with setæ which are nearly as long as diameter of tibia; tarsi slightly striate, with four long fine capitate setæ at apex; fore and middle tarsi with a median stiff seta and two much longer lateral setæ on basal segment, hind tarsi bearing only two very long setæ. Wings somewhat infuscated along veins; first and second oblique veins on forewings united at bases, third obsolete on basal part, once branched; hind wings with two divergent oblique veins and two or three hooklets. Length of body, 2.0 millimeters; head including front ocellus, 0.248, width of head including eyes, about 0.53; length of antenna, 0.8; width of antennal segment three excluding sensoria, 0.035; diameter of cornicle at apex, 0.042; diameter of sclerotized area at base of cornicle, 0.085; width of cauda, 0.083; width of anal lobe, 0.09;

length of hind tibia, 0.65; width of hind tibia at middle, 0.037; length of hind tarsus, 0.115.

Grown nymph of winged viviparous female.—Head sclerotized on dorsum except on lateral part and on a longitudinal median line, fused with pronotum, with a short blunt tubercle on front, which is divided on distal part. Front with a pair of small spines, each of which arises from a small tubercle; two pairs of smaller spines present on ventral side of head near front. Prothorax and abdominal segments with wax pores in a row on side.

Host.—*Arundinaria* sp.

Habitat.—Shin Taiheizan (altitude about 6,000 feet), Taihoku Prefecture.

Many winged forms and the nymphs were taken by me October 15, 1937. The winged form is unknown.

In *Cerataphis lataniæ* Boisduval the grown nymph of the winged form has a pair of short blunt tubercles on the front, each of which is provided with two spines at the tip.

THORACAPHIS MIRABILIS sp. nov.
Text fig. 3.

Wingless viviparous female.—Black, strongly sclerotized, with no wax. Body oval, prominently reticulate on dorsum of cephalothorax, somewhat corrugated and indistinctly somewhat reticulate on basal seven abdominal segments, which are fused together. Cephalothorax very large, with about twenty stout flattened setæ in a row along entire margin, which are equal in length, somewhat broadened towards apex, mostly curved and reaching far beyond margin of body; a pair of similar setæ present on median area between eyes; four pairs of minute blunt setæ on median area of thorax. Eyes submarginal, dorsal, con-

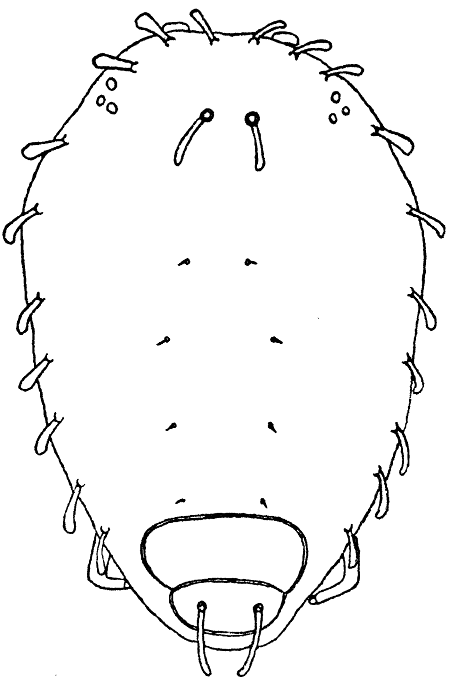

FIG. 3. *Thoracaphis mirabilis* sp. nov.; wingless viviparous female.

sisting of three facets. Antennæ small, not segmented, directed laterally, black, visible from above, with a subapical seta. Abdomen much reduced in size, separated from thorax, with no marginal rim; segment eight separated from basal part of abdomen, rounded on hind margin, with a pair of longer blunt setæ. Cornicles absent. Cauda knobbed, pale. Anal plate divided, lobes wider than long, pale. Genital plate rounded on hind margin, with about eight long setæ in a row on hind margin. Fore and middle legs concealed under body; hind legs exposed, black, not reaching hind end of body; hind tarsi short, not segmented, a little longer than wide, rounded apically, without claws. Length of body about 0.425 millimeter, width, 0.3; width of abdominal segment eight, 0.078; length of hind tibia, 0.046.

Host.—*Ficus* sp., on nether surface of leaf.

Habitat.—Dainano, Suo-gun, Taihoku Prefecture.

Many specimens cemented to the leaves were collected by me October 19, 1937.

Closely allied to *Thoracaphis fici* Takahashi, but differing in the smaller and narrower body and in the shorter flattened setæ along the body margin, as well as in the absence of wax on the body margin.

The materials upon which the present paper is based are deposited in the collection of the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATIONS

TEXT FIGURES

PLANKTON STUDIES IN FORMOSAN INLAND WATERS [1]

By MASUZO UÉNO

Of the Hydrobiological Station, Otsu (Shigoken), Japan

ONE PLATE AND ONE TEXT FIGURE

In recent years a great deal of work has been carried out on the plankton of Japanese inland waters, but these investigations were restricted chiefly to the middle and northern regions of the country. Little work has been done on the plankton of Taiwan (Formosa), whose inland waters, due to the subtropical climate of the island, are markedly different from those in the northern regions of Japan. The zoöplankton study of Zitugetu-tan (Lake Candidius by Harada(6) has been the only contribution hitherto published.[2]

A large series of plankton catches was made during three limnological expeditions to Taiwan, aided by research funds from the Hattori Hokokai: In April, 1935, undertaken by Dr. D. Miyadi; in July of the same year, by the present writer and Mr. K. Okugawa; and in January, 1937, by Doctor Miyadi. Of the material mentioned, four groups of animals have already been worked out,—the free-living Copepoda by Kikuchi (1936, in part) and Kiefer,(13, 14) the Cladocera and Rotatoria by Uéno.(31, 32) In the present paper are discussed the general ecological problems of the inland waters, with special reference to their plankton. A discussion of certain groups of plankton animals of zoögeographical interest has been published in another paper.(33)

I wish to express my cordial thanks to Dr. D. Miyadi for making it possible for me to undertake the expedition in July, 1935, and for helping me in various ways. My thanks are also due to Mr. K. Okugawa who assisted during the expedition; and to those who kindly identified various groups of organisms. For the financial aid granted by the Hatori Hokokai I offer my hearty thanks.

[1] Contribution from the Otsu Hydrobiological Station of Kyoto Imperial University.

[2] Since the present article was written an extensive limnological and plankton study of Sango-tan was published by Harada.(7, 8) These papers are, however, only briefly referred to in footnotes of the present article.

The lakes and lakelets.—The inland waters studied may conveniently be divided into two different groups. The first group consists of those whose basins are relatively large in area and depth, and situated in the low plains or lower mountains. Zitugetu-tan [3] (Lake Candidius), Sango-tan, Kotohi Dam, Ryurantan, Rigyo-ti, and Toa-pi belong to this group. A number of lakelets and ponds on the northern part of the central mountain range as high as 2,300 to 2,600 meters above the sea belong to the second group. In the first expedition in April, 1935, four representative lakes, namely, Zitugetu-tan, Sango-tan, Rigyo-ti, and Toa-pi were investigated. A large irrigation dam, Kotohi, left unexplored in the preceding two expeditions, and these lakes, with the exception of Toa-pi, were again visited in January, 1937. In the second expedition in July, 1935, besides the three lakes, Zitugetu-tan, Sango-tan and Ryuran-tan, a number of high mountain lakelets were visited.

Methods.—In all the lakes except Kotohi dam, two sets of plankton catches were made with a small quantitative net of fine bolting silk, one set being hauled vertically at the deepest point of each lake from the bottom to the surface and the other horizontally. At Zitugetu-tan vertical hauls were made in both basins, Zittan and Gettan, in the same way as at the other lakes. In other localities, where no boat was available, the samples were secured with a small tow net or a hand net near the shore. The catches were counted in the Otsu Laboratory, two or three samples (usually 1 cc) being used from each catch. The results are presented according to their relative abundance in numbers calculated on a percentage basis.

Some physical and chemical determinations were made in the field. Transparency was determined with a Secchi white disc 25 cm in diameter. The determination of temperature and the hydrogen-ion concentration of the water was made in every case, and in the larger lakes equipped with a boat the vertical series of the dissolved oxygen content and of the alkalinities were also determined. Dissolved oxygen was determined by the usual Winkler's method; the alkalinity was determined by titration with n/10 hydrochloric acid for 100 cc of water, methyl-orange

[3] "Tan" is the Formosan word for "lake."

being used as indicator.(25) The hydrogen-ion concentration was determined colorimetrically by means of Clark-Lubbs' standard buffer solutions. The oxygen saturation was calculated on the basis of Fox's table. The oxygen data obtained by Miyadi are also cited in the present paper in unchanged form, though his data are represented in mg per liter of water.

ACCOUNT OF THE PLANKTON

ZITUGETU-TAN (LAKE CANDIDIUS)

Zitugetu-tan is the largest natural lake in Taiwan. Its maximum depth was only 5 meters(6) until 1934, when it was dammed as a reservoir for hydroelectricity and filled with water from a mountain stream. At present its maximum depth is about 18 meters.

The lake consists of two parts, an eastern larger basin called Zittan and a western smaller basin called Gettan, the former being deeper than the latter. The surface area is 7.74 square kilometers, but varies with the great variations in the water level. The altitude of the lake surface is about 740 meters above sea level.

The physical and chemical results obtained at three visits are shown in Table 1.

In spite of its high altitude the deep water of this lake is remarkably warm in summer, being above 20° C. in the middle of July, though the surface water is not so markedly warm. The thermocline does not develop distinctly. The dissolved oxygen content decreases greatly in the deep water in summer.

Since the lake has begun to receive the water of the mountain stream, Dakusui-kei, the chemical composition of its water has changed remarkably, the salt content having become from four to five times that before 1934. It will be clear from the results of chemical analysis of the water hitherto analysed (Table 2) that the calcium, magnesium, sulphate, and carbonate contents have also remarkably increased.(37) These salts, consisting chiefly of carbonate or sulphate of lime, have been brought into the lake by the Dakusui-kei, which drains through clay slates in its basin and dissolves out a large amount of the salts.

TABLE 1.—*Physical and chemical characteristics of Zitugetu-tan (Lake Candidus).*

ZITTAN BASIN.

Depth.	April 19, 1935, Miyadi.				July 14, 1935, Uéno.					January 1, 1937, Miyadi.			
	Temperature.	pH.	Oxygen.		Temperature.	pH.	Oxygen.		Alkalinity.	Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg/1.*	*Per cent.*	°*C.*		*cc/1.*	*Per cent.*	*cc:100.*	°*C.*		*mg/1.*	*Per cent.*
0	23.9	8.3	8.54	89	27.8	8.0	4.82	79	1.28	19.8	7.7	7.74	75
1					27.4	8.0							
2	23.7	8.0	8.68	90						19.7	7.6	7.61	74
3					27.4	8.0							
4	22.1	8.0	10.06	108	27.0	7.8				19.7	7.6	7.45	72
5					25.0	7.6	6.15	96	1.40				
6	20.0	7.8	10.08	105						19.7	7.6	7.46	72
10	18.7	7.7	9.70	92	23.2	7.4	4.70	71	1.52	19.1	7.5	8.02	76
11										19.0	7.4	7.41	71
13					21.8		1.18	18	1.50				
14	18.2	7.3	6.70	63									
15					21.5	6.9	0.16	2	1.50				
16	18.0	7.1	4.82	46	20.2		0	0	1.76				
16.5	18.0	7.1	4.14	39									
	Transparency 3.5 m.				Transparency 5 m.					Transparency 3.2 m.			

GETTAN BASIN.

0	22.8	8.1	7.47	76	29.3	8.0	5.05	86	1.32	19.5		6.98	67
1					28.1	7.95							
2	22.7	8.1	7.16	73									
4	22.0	7.9	8.69	87									
5	20.4	7.9	10.22	99	25.6	7.8	5.68	87	1.46	19.5		6.75	65
7										19.5		6.91	66
8	19.4	7.7	9.01	87		7.6							
10	19.0	7.7	9.54	91	23.7	7.4	4.46	69	1.50				
13					21.8	7.0	0.35	5	1.56				
14	18.3	7.2	5.08	47									
14.3					21.7	6.85	0	0	1.66				
14.5	18.2	7.2	4.33	41									
	Transparency 3.7 m.				Transparency 5 m.					Transparency 2.4 m.			

TABLE 2.—*Chemical analysis of the waters of Zitugetu-tan.*[a]

Year.	Depth.	pH.	Total solids.	Na.	Ca.
	m.				
1919	0		59.0	11.3	2.2
1933	0		45.3	2.9	1.1
1935	0	8.3	206.4	11.3	44.3
	15	7.2	215.6	8.7	50.5

Year.	Mg.	SO_4.	CO_2.	SiO_2.	P.	N.
1919	1.1	12.2	27.2	5.9		
1933	3.1	1.1	11.3	3.9	0.012	0.15
1935	20.1	41.5	55.6	8.9	0	0.19
	15.8	60.8	55.8	9.1	0	0.24

[a] Figures represent mg. per liter of water.

Owing to this marked change in the chemical composition of the water, there is a rather remarkable change in the composition of the plankton. Harada(6) has listed more than 30 species of zoöplanktons, 10 of copepods, 7 of cladocerans, 9 of rotatorians, and several of protozoans, nematodes, and insect larvæ (Diptera, Chaoborinæ), though his list contained several littoral species. In the material obtained on our three expeditions, however, the number of species of plankton animals remarkably decreased, and at the same time several hitherto unrecorded forms appeared.

The species of plankton animals and their relative numerical abundance at three different seasons are given in Table 3.

Zoöplankton.—As will be seen from the list, the present plankton fauna of the lake is composed chiefly of Copepoda, among which *Mongolodiaptomus formosanus* is the dominant species in both basins of the lake, and in every season comprises more than 30 per cent of the total plankton, often attaining 60 per cent (in April). This calanoid was recorded by Harada(6) under the name of *Diaptomus Birulai* Rylov, but, according to Kiefer,(13) the Candidius form is a new species and is to be placed under his genus *Mongolodiaptomus.* The 9 species of Cyclopoida recorded by Harada, with the exception of *Mesocyclops leuckarti,* were not found on our three expeditions. It is to be noted that there was found a recent immigrant of Cladocera; namely, *Ceriodaphnia rigaudi,* which, although the most common ceriodaphnid in Formosan inland waters,(31) was formerly not found in this lake. This warmth-tolerant form as well

TABLE 3.—*Composition of plankton of Zitugetu-tan.*[a]

Species.	April, 1935.		July, 1935.		January, 1937.	
	Z.	G.	Z.	G.	Z.	G.
	Per cent.	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*
Rotatoria:						
Brachionus calyciflorus			0.2			
Brachionus forficula[b]						7.4
Schizocerca diversicornis[b]			0.9	0.3		
Keratella valga tropica[b]						0.2
Filinia longiseta[b]	12.5	63.0				
Tetramastix opoliensis brevispina					0.3	0.8
Pedalion mirum[b]	0.1	0.1		0.9	9.7	1.0
Pompholyx complanata					0.3	0.8
Cladocera:						
Diaphanosoma brachyurum[b]	14.0	8.0	2.6	6.5	2.0	
Ceriodaphnia rigaudi	4.0	1.9	10.1	15.3	8.9	19.8
Bosmina longirostris[b]	0.6	1.0	9.0	7.4	16.4	9.5
Alona rectangula	0.6					
Copepoda:						
Mongolodiaptomus formasanus[b]	59.6	17.6	33.9	41.0	34.7	30.4
Mesocyclops leuckarti[b]		1.9	33.4	21.5	16.7	14.4
Nauplii[b]	8.5	6.5	9.9	7.1	11.0	15.7
	100.0	100.0	100.0	100.0	100.0	100.0

[a] Z and G represent the Zittan basin and Gettan basin, respectively.
[b] Found also in Harada's list.

as two other common cladocerans, *Diaphanosoma brachyurum* and *Bosmina longirostris,* seem to appear in the lake throughout the year. Several littoral cladocerans recorded by Harada (6) are not represented in our material, except *Alona rectangula.* It is probable that this is chiefly due to the immersion of the swamplike marginal regions of the Gettan basin due to the raised water level of the power dam. Of the rotatorians, *Pompholyx complanata, Tetramastix opoliensis brevispina,* and *Brachionus calyciflorus* are new members of the lake.

Phytoplankton.—The phytoplankton appeared to be very scarce, a very slight development of *Microcystis* water bloom being seen in April and July.

Bottom deposits.—The floor of the lake is extensively covered with a gelatinous mass of a blue-green alga, probably *Aphanotheca,* and also "Feindetritusgyttja" (18) rather rich in diatoms. This algal deposit peculiar to this lake is regarded as "Bodenalgenäwja." (22) Shibuya et al. (26) obtained the carbonitrogen ratio 5.90 : 8.67 for the bottom deposit of this lake.

Owing to the great change in the water level, a marked variation has occurred in the fauna and flora of the lake, as shown in

the composition of the plankton stated above. Nine species of flowering aquatic phanerogams ever growing in this lake (16) are not found at present. This is one of the important reasons for the disappearance of littoral forms in the plankton catches. The midge larva of the subfamily Chaoborinæ (Corethrinæ) which was observed by Harada as a plankton in this lake was quite absent in our studies, not only in the plankton catches but also in many bottom-mud samples taken up by an Ekman-Birge botton sampler.

Zitugetu-tan is regarded at present as a gypsotrophic phase of the eutrophic type of lake, as will be discussed in a later chapter. However, vegetable substances such as tannin, humus, and the like, which were extracted from the sunken forest around the lake due to the rise of the water level (Plate 1, fig. 1), may have a marked modifying effect upon the water as well as the plankton fauna and flora of the lake. The effect of the sunken forest in changing a lake type was pointed out recently by Thienemann (28) in connection with several lakes of the low plains in northern Germany, where the rise of the underground water level has had a remarkable effect upon the marginal forest of those lakes.

SANGO-TAN (UZANTO DAM)

Among the artificial lakes in Taiwan, Sango-tan is the largest and deepest. It lies north of the city of Tainan and was constructed to irrigate the rice fields in the vicinity of that city. Its surface area is 10.10 square kilometers; the maximum depth is 31 meters at full water; the altitude of the lake surface is 58.2 meters.

The physical and chemical data obtained during three expeditions are given in Table 4.(7, 8)

The deep-water temperature is above 25°C. in July and exceeds 20°C. even in January. The formation of the thermocline is not distinct. The dissolved oxygen greatly diminishes even in April, being entirely absent below 18 meters. In July, 1935, however, there was observed a remarkable "complex stratification" (35) which may probably be due to the introduction of a large volume of cold water from the stream Sôbun-kei. The origin of the alkaline water of this lake is similar to that of Zitugetu-tan.

Zoöplankton.—The composition of the plankton does not differ essentially from that of Zitugetu-tan as stated above; the copepods are similarly the most important component and oc-

TABLE 4.—*Physical and chemical characteristics of Sango-tan.*

Depth.	April 17, 1935, Miyadi.				July 12, 1935, Uéno.					January 3, 1937, Miyadi.			
	Temperature.	pH.	Oxygen.		Temperature.	pH.	Oxygen.		Alkalinity.	Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg/1.*	*Per cent.*	°*C.*		*cc/1.*	*Per cent.*	*cc:100.*	°*C.*		*mg/1.*	*Per cent.*
0	29.7	8.4	8.85	107	30.6	9.0	6.64	126	1.24	20.2	7.8	7.74	83
1					30.7	9.0			1.26				
2	26.9	8.4	10.29	123	29.8	8.8				20.2	7.8	7.83	
3					28.4	7.6	3.12	57	1.20				
4	24.5	7.9	6.16	71						20.1	7.8	7.78	
5					27.5	7.4	2.22	40	1.54				
6	22.5	7.5	2.22	25						20.1	7.8	7.84	
8	21.2	7.4	2.00	22						20.0	7.8	6.68	
10	20.4	7.4	1.59	17	26.4	7.4	3.36	59	1.44	20.0	7.8	7.96	85
12	20.0	7.4	0	0						20.0	7.85	7.75	
14	19.8	7.4	0							20.0	7.85	7.78	
16	19.7	7.4	0							19.8	7.8	7.97	85
										(16.5 m.)			
18	19.7	7.4	0										
20					25.7	7.5	4.24	73	1.40				
25					25.6	7.5	3.28	56	1.30				
26					25.5	7.4	2.70	47	1.40				
	Transparency 2.1 m.				Transparency 0.5 m.					Transparency 1.2 m.			

cupy more than 50 per cent of the total plankton. In Sango-tan, however, differing from Zitugetu-tan, *Mongolodiaptomus formosanus* is inferior to the three species of Cyclopoida, namely, *Mesocyclops leuckarti, Thermocyclops hyalinus,* and *T. taihokuensis.* The Cladocera fauna is characterized by the occurrence of a tropical element, *Diaphanosoma paucispinosum,* which originated in the Sunda region and does not occur in Zitugetu-tan. It is of interest ecologically that two different species of *Diaphanosoma,* one the northern *D. brachyurum* and the other the southern *D. paucispinosum,* mentioned above, coëxist in this lake. This may be explained in part, as the writer stated in another place, (31) by the fact that the water temperature of the lake is not too warm for *D. brachyurum* and not too cold for *D. paucispinosum.*

TABLE 5.—*Composition of the plankton of Sango-tan.*[a]

Species.	April, 1935.	July, 1935.	January, 1937.
	Per cent.	*Per cent.*	*Per cent.*
Rotatoria:			
Trichocerca capucina			1.4
Brachionus calyciflorus	0.3	21.8	7.8
Brachionus forficula	2.4	0.3	2.0
Schizocerca diversicornis	1.5	4.6	1.0
Keratella valga tropica	1.8	0.3	2.7
Asplanchna priodonta	3.2	2.6	
Tetramastix opoliensis brevispina		0.3	0.3
Pedalion mirum			0.3
Pompholyx complanata	0.3		
Cladocera:			
Diaphanosoma paucispinosum	5.9	9.0	6.8
Diaphanosoma brachyurum	2.0	3.0	2.0
Ceriodaphnia rigaudi	7.7	2.5	0.3
Bosmina longirostris			1.7
Copepoda:			
Mongolodiaptomus formosanus	13.3	9.5	15.6
Cyclops spp.[b]	52.0	36.3	31.9
Nauplii	9.6	9.9	26.2
Insecta:			
Chaoborinæ larvæ		0.3	
	100.0	100.0	100.0

[a] Besides the species listed in this table, Harada (8) recorded the following ten forms: *Peridinium* sp., *Polyarthra platyptera, Diurella stylata, Dinocharis intermedia, Monostyla* sp., *Keratella cochlearis, Mesocyclops thermocyclopoides, Eucyclops prasinus candidiusi, Ergasilus japonicus,* and a free-living nematode. Three species appearing in the present table; namely, *Bosmina longirostris, Mesocyclops leuckarti,* and *Thermocyclops hyalinus,* are not recorded by Harada. (8)

[b] *Mesocyclops leuckarti, Thermocyclops hyalinus,* and *T. taihokuensis.*

Phytoplankton.—The phytoplankton appeared to be extremely scarce, being limited to a small number of *Ceratium hirundinella* (O. F. Müller) found in the July collection.

Bottom deposits.—The bottom deposit from a depth of 18 meters consists chiefly of "Feindetritusgyttja" containing a large amount of fine sand. No diatoms were found.

KOTOHI DAM

This irrigation dam is situated some 3 kilometers east of the town of Sinka, north of Tainan. Its surface area is 0.24 square kilometer; the maximum depth is about 12 meters; the altitude of the lake surface is 40 meters above sea level. This reservoir was visited only once by Miyadi, January 4, 1937. As there was no boat on the lake, only a littoral collection was made. The temperature of water near the shore was 20.3°C. (at 11 A. M.) and the pH of the water was 7.9; the water was remarkably turbid.

Plankton was very scarce, being composed chiefly of copepodean nauplii, no phytoplankton being found at all.

TABLE 6.—*Composition of plankton of Kotohi, January, 1937.*

	Per cent.
Polyarthra trigla	4.6
Brachionus calyciflorus	19.0
Brachionus forficula	4.0
Keratella cochlearis tecta	3.1
Keratella valga tropica	3.4
Schizocerca diversicornis	17.2
Scapholeberis mucronata	0.3
Bosmina longirostris	0.6
Alona intermedia	0.6
Mongolodiaptomus formosanus	2.1
Thermocyclops taihokuensis	12.3
Nauplii of Copepoda	32.8
	100.0

RYURAN-TAN

Ryuran-tan is a small lake occupying a shallow basin some 2.5 kilometers south of the town of Kôsyun that lies almost in the southern end of the island of Taiwan. The depression in which the lake lies is said to have been covered formerly by the sea. Therefore the lake may be regarded as a marine relic. The altitude of the lake surface is about 14 meters. The lake is fed by a spring which wells up to the west of the lake and discharges in the north. The surface area of this lake is about 0.97 kilometer; the greatest length being about 2 kilometers and the greatest breadth 0.7 kilometer. Miyadi (20) obtained a maximum depth of only 1 meter, January 6, 1937, while during my visit July 9, 1935, at which time the water level was observed

to rise, the deepest point of 1.5 meters was obtained. In both visits the water was remarkably turbid and yellow-opaque.

The physical and chemical observations made in two visits are recorded in Table 7.

TABLE 7.—*Physical and chemical characteristics of Ryuran-tan.*

Depth.	July 9, 1935, Uéno.					January 6, 1937, Miyadi.			
	Temperature.	pH.	Oxygen.		Alkalinity.	Temperature.	pH.	Oxygen.	
m.	°*C.*		*cc./l.*	*Per cent.*	*cc: 100.*	°*C.*		*mg/l.*	*Per cent.*
0	28.8	7.4	4.77	87	1.20	21.8	8.0	8.13	90
0.5						21.8	8.0	9.32	100
1	28.7	7.6	4.74	87	1.52	21.8	8.0	7.79	86
1.5	28.5	7.4	3.67	67	1.40				
	Transparency 10 cm.					Transparency 25 cm.			

Plankton.—The plankton and its relative abundance are summarized in Table 8.

TABLE 8.—*Composition of plankton of Ryuran-tan.*

Species.	July 9, 1935.	January 6, 1937.
	Per cent.	*Per cent.*
Rotatoria:		
Trichocerca capucina		9.3
Brachionus angularis		4.6
Brachionus forficula laevis	0.3	
Brachionus angularis caudatus		0.1
Keratella cochlearis tecta		0.1
Keratella valga tropica	0.3	1.8
Schizocerca diversicornis		0.1
Filinia longiseta	0.3	1.5
Polyarthra trigla		0.3
Pedalion mirum		1.8
Pompholyx complanata		31.5
Noteus militaris	0.6	
Monostyla bulla	0.3	
Cladocera:		
Diaphanosoma paucispinosum	5.6	1.6
Alona diaphana	0.3	
Copepoda:		
?*Mongolodiaptomus uénoi*	61.8	11.0
Cyclops sp. (young)	15.3	1.6
Nauplii	14.0	34.7
Decapoda: Zoëa	0.9	
Oligochæta: Naididæ	0.3	
	100.0	100.0

In July the plankton, though comparatively abundant, is restricted qualitatively, being represented chiefly by Copepoda.

No phytoplankton was found. In January the zoöplankton consists of a large variety of animals, especially rotatorians, of which *Pompholyx complanata* is the most abundant, representing more than 30 per cent of the total plankton. Among the three species of the genus *Brachionus, B. angularis caudatus* is the most noticeable. This form has never occurred in any other lake in Taiwan.(32)

Ryuran-tan is the most productive of zoöplankton of any of the lakes studied in Taiwan. This is true particularly with regard to the bottom fauna of this lake, which is exceptionally productive especially of mollusks in the Formosan lakes.(20)

RIGYO-TI

Rigyo-ti, though a small lake having a surface area of only 1.03 square kilometers, is the largest natural lake on the east coast of Taiwan Island. It lies in a closed basin between the streams Mokkui-kei and Rô-kei, some 10 kilometers southwest of the town of Karenko, and it is thought that the lake owes its existence to a large alluvial fan damming up the northern end of the basin. The lake was first sounded by Miyadi,(19) who obtained a maximum depth of 9 meters in the middle of the east side; in January, 1937, however, he failed to find a point deeper than 7.5 meters.(20) There has been slight change in the water level.

The physical and chemical results are shown in Table 9.

TABLE 9.—*Physical and chemical characteristics of Rigyo-ti, D. Miyadi.*

Depth.	April 11, 1935.				January 10, 1937.			
	Temperature.	pH.	Oxygen.		Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg/l.*	*Per cent.*	°*C.*		*mg/l.*	*Per cent.*
0	22.0	8.4	9.11	100	18.8	7.2	8.98	94
1	22.0	8.4	8.38	93	----	----	----	----
2	21.9	8.4	9.16	100	18.9	----	8.87	93
3	21.7	8.4	8.68	95	----	----	----	----
4	20.9	8.4	12.15	131	18.9	----	8.95	93
5	19.9	6.5	4.22	45	----	----	----	----
6	19.2	6.2	0.85	9	18.8	----	8.91	93
7	18.8	6.3	0	----	18.8 (7.5 m.)	7.5	8.65	90
8	18.7	6.3	0	----	----	----	----	----
8.5	18.7	6.3	0	----	----	----	----	----
	Transparency 1.8 m. Color forel-ule.				Transparency 2.9 m. Color IX.			

Unfortunately the summer temperature of the lake has never been observed. In comparison with the deep-water temperature in both April and July, the turnover may have been already completed by the beginning of April. Dissolved oxygen was entirely absent in the deep water even in April.

Zoöplankton.—The zoöplankton was very scarce in the number of species and of individuals. In April there occurred only one species of Copepoda, *Thermocyclops hyalinus,* and a rotifer, *Brachionus calyciflorus,* but in January, besides the above-named copepod, there occurred five species of rotifers, of which *Brachionus budapestensis* and *Keratella cochlearis* were most abundant. Rhizopod protozoans were also found.

TABLE 10.—*Composition of plankton of Rigyo-ti.*

Species.	April, 1935.	January, 1937.
	Per cent.	*Per cent.*
Difflugia acuminata		0.3
Arcella vulgaris		0.3
Polyarthra trigla		0.7
Brachionus calyciflorus	0.1	2.5
Brachionus budapestensis		4.9
Keratella cochlearis tecta		4.6
Trichocerca capucina		0.7
Thermocyclops hyalinus	96.0	46.2
Nauplii of Copepoda	3.9	39.8
	100.0	100.0

Phytoplankton.—Contrasted with the paucity of zoöplankton, an enormous quantity of water bloom, consisting chiefly of blue-green algæ and diatoms, appeared even as early as January. Such a remarkable development of water bloom was recorded at no other time in connection with the Formosan lakes studied. The composition of the water bloom, in January, 1937, is shown in Table 11. (determined by Mr. K. Negoro). It is characterized by an enormous occurrence of *Microcystis* species and of *Dimorphococcus lunatus* (green alga). The diatom *Melosira granulata* is also abundant.

TABLE 11.—*Composition of phytoplankton of Rigyo-ti, January, 1937.*

Species.	Per cent.
Microcystis acruginosa Kütz.	28.5
Microcystis flos-aquae (Wittr.)	2.1
Lyngbya limnetica Lemmermann	6.3

Species.	Per cent.
Dimorphococcus lunatus A. Braun	36.5
Pediastrum, 2 spp.	0.9
Dictyosphaerium sp. and *Westella* sp.	2.2
Scenedesmus quadricauda (Turpin)	0.3
Staurastrum sexangulare (Bulnh.) and *Staurastrum* sp.	0.5
Peridinium sp.	0.2
Ceratium hirundinella (O. F. Müller)	3.2
Melosira granulata (Ehrenberg)	18.4
Synedra sp.	0.9
	100.0

Bottom deposits.—The sediment from the bottom of 8.5 meters is yellowish dark brown and is designated "Algengyttja,"(19, 22) containing a large quantity of diatoms. The amorphous fine detritus which forms the sediment is really derived from the blue-green algæ inhabiting the upper water mass, though the algal structure is not preserved.

TOA-PI

Toa-pi is a small and shallow lake lying north of the town of Taito on the east coast of the island. Its surface area is only 0.53 square kilometers, and no soundings of over 3 meters were obtained in the central part. The altitude of the lake surface is 263 meters above sea level. This lake was visited only once by Miyadi, April 14, 1935. The physical and chemical characteristics of Lake Toa-pi are shown in Table 12.

TABLE 12.—*Physical and chemical characteristics of Toa-pi, April 14, 1935, D. Miyadi.*

Depth.	Temperature.	pH.	Oxygen.	
m.	°*C.*		*mg.*	*Per cent.*
0	24.1	8.9	7.78	89
1	23.6	8.3	7.35	83
2	23.3	7.8	7.37	83
2.8	22.2	7.5	5.05	56
	Transparency 0.7 m.			

Plankton.—No phytoplankton occurs. The zoöplankton is not abundant, consisting chiefly of the copepod, *Thermocyclops taihokuensis.* Table 13 shows the composition of the plankton of Lake Toa-pi.

TABLE 13.—*Composition of the plankton of Toa-pi, April, 1935.*

Species.	Per cent.
Difflugia sp.	0.1
Trichocerca capucina	0.1
Keratella valga tropica	0.5
Filinia longiseta	1.1
Diaphanosoma paucispinosum	6.5
Thermocyclops taihokueneis	91.5
Copepoda nauplii	0.2
	100.0

Bottom deposits.—The bottom mud from a depth of 3 meters is yellowish gray and is characterized as "Feindetritusgyttja," very rich in fine sand, and without diatoms.

SMALL LAKES ON THE CENTRAL MOUNTAINS

A number of small lakes lying on the northern high mountain ranges was investigated by the second expedition in July, 1935. All of them are in the forest zone at altitudes between 2,300 and 2,600 meters above sea level on the ridges around Mount Nanko-Taizan (3,797 meters). Some of these waters were studied by Kano. (12)

The physical and chemical observations made in the field are shown in Table 14.

TABLE 14.—*Physical and chemical characteristics of the mountain lakes.*

Lake.	Altitude.	July, 1935.	Time.	Temperature.		pH.
				Air.	Water.	
	m., ca.		*hr. min.*	°*C.*	°*C.*	
Siron Mahayahen	2,300	20	11 00	22.5	23.0	5.0
Siron Mururoahu	2,300	20	1 00	23.5	25.3	5.2
Myoto-ike	2,200	23	16 00	19.5	19.8	5.8
Zigoky-ike	2,300	23	16 45	17.2	18.5	5.6
Matumine (upper)	2,591	24	8 00	14.0	15.7	5.4
Matumine (lower)	2,500	24	7 40		15.5	5.4
Matumine periodic pool A		23	17 30	16.5	16.3	5.8
Matumine periodic pool B		23	18 00	14.5	15.7	5.4

The water temperature in most cases is below 20°C. The temperature of the upper pond of Matumine, which is the highest elevated lake studied by the expedition, about 15°C., was taken in the morning. The meteorological data obtained by the members of the Matumine policemen's station are cited in Table 15.

TABLE 15.—*Meteorological data at Matumine, for 1934 (at 2 p. m.)*.[a]

Data.	I	II	III	IV	V	VI
TEMPERATURE, °C.:						
Maximum	9.0	11.7	13.4	20.0	19.0	21.0
Minimum	—5.5	—1.7	—4.5	3.3	7.2	10.0
Mean	4.0	5.7	4.1	10.2	14.1	16.5
PRECIPITATION:						
Millimeters	136.0	153.8	552.9	307.0	357.9	268.4

Data.	VII	VIII	IX	X	XI	XII	Mean.
TEMPERATURE, °C.:							
Maximum	21.7	22.2	22.2	18.0	15.6	17.8	22.2
Minimum	12.2	16.7	10.5	7.2	6.1	—3.9	—5.5
Mean	18.6	19.5	16.7	14.4	10.9	10.1	12.0
PRECIPITATION:							
Millimeters	737.8	39.8	310.1	51.4	73.4	32.5	8.28

[a] The original data are given in ° F.

The water of these lakelets is usually acid, the pH values being below 6, and of those surrounded by *Sphagnum* moor as low as 5. From the low pH values of certain periodic pools formed by rain on the preceding day, it is supposed that the acidity of the lakes studied originates from the soil around them, especially in the cases of the Matumine ridge.

Siron Mahayahen.—On the ridge extending in the southeastern direction from Mount Nanko-Taizan (3,797 meters) to Mount Sansei-zan (2,351 meters) there are a number of boglike shallow lakes, of which Siron[4] Mahayahen is representative. It lies in a dense forest of pines at an altitude of about 2,300 meters. It is an irregular ellipse in outline, the greatest length being about 100 meters, and is bordered by the *Sphagnum* moor which is contiguous to the pasture on the southwestern shore. The greatest depth seems to be less than 0.5 meter. The water is clear, but appears to be remarkably brown due to the humic mud covering the bottom. No net phytoplankton was visible, but zoöplankton, restricted qualitatively, was abundant, consisting chiefly of two species of intensely red copepods and the cladocerans *Diaphanosoma brachyurum,* as shown in Table 17. Among the copepodean nauplii found during my visit, the diaptomids were more numerous than the cyclopoids.

Siron Mururoahu.—A very small round body of water with a diameter of some 25 meters, lying at an altitude of about 2,310

[4] "Siron" means "lake" according to the savage Atayal vocabulary.

meters. It is bordered by *Sphagnum* moor, except for a small hill side on the northeastern side, and is covered with an overgrowth of *Scirpus mucronatus* Linné. The depth is unknown, but it is probably no more than 1 meter. The water is dark blackish brown, due not only to the extract from the marginal moor but also to much wood submerged in the water. The plankton does not differ essentially in composition from that of Siron Mahayahen; a considerable mass of *Diaphanosoma brachyurum* and of intensely red copepods were taken.

Small lakes on the Matumine ridge.—The following four small bodies of water lie in the small fault along the ridge of Matumine, on the western side of the range of Mount Nanko-Taizan. The physical and chemical data obtained by Kano are cited in Table 16.

TABLE 16.—*Physical and chemical analysis of waters of high mountain lakes.*[a]

Lake.	Date.	Time.	Temperature.	pH.	Oxygen.
	Nov., 1938	*hr. min.*	°C.		*cc/l.*
Myoto-ike	22	13 10	15.0	6.0	5.33
Zigoku-ike	24	9 00	7.5	6.0	4.82
Matumine (upper)	23	7 00	3.0	5.8	4.05
Matumine (lower)	23	9 00	8.5	6.0	5.55

Lake.	Total solids.	Ca.	Mg.	Cl.	N.	$KMnO_4$ consumed.
Myoto-ike	[a]23.7	[a]0.8	[a]1.5	[a]11.0	[a]0.32	[a]17.0
Zigoku-ike	26.2	1.2	0.5	10.1	0.54	16.5
Matumine (upper)	88.4	1.2	0.6	0.6	1.22	108.0
Matumine (lower)	15.2	1.1	0.4	1.1	0.07	23.0

[a] Figures represent mg per liter of water, except for oxygen and pH.

Myoto-ike.—Elliptical in outline, 50 by 35 meters, with a steep shore, surrounded by pasture and forest pine. Water dark greenish brown. Zoöplankton abundant, consisting of red copepods and *Diaphanosoma brachyurum.*

Zigoku-ike.—A small lake, 30 by 20 meters, nearly circular in outline. Water dark greenish brown. Zoöplankton composed of red copepods and *Diaphanosoma. Daphnia pulex obtusa* also found.

Upper pond of Matumine.—A small body of water, circular in outline, only 15 meters in diameter. Water dark reddish brown, typical of the dystrophic water in this district. Zoöplankton

very abundant, consisting of intensely red copepods and *Daphnia pulex obtusa.*

Lower pond of Matumine.—A small body of water lying about 1 kilometer north of the above lakelet, nearly triangular in outline; diameter about 10 meters. Water clear but somewhat yellowish brown. Zoöplankton not differing essentially from that of the upper pond, but much less productive.

The zoöplankton of the six lakelets described above is summarized in Table 17.

The plankton of the lakelets studied are, without exception, copepods and cladocerans, neither protozoans nor rotifers being found. The cyclopoid *Tropocyclops prasinus* is distributed in

TABLE 17.—*Plankton of small mountain lakes.*

Species.	Siron Mahayahen.	Siron Muruoahu.	Myoto-ike.	Zigoku-ike.	Matumine upper pond.	Matumine lower pond.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Neutrodiaptomus tumidus, female	16.1	38.3	17.0	37.0	45.4	--------
Neutrodiaptomus tumidus, male	1.9	3.4	3.7	1.9	14.3	--------
Neutrodiaptomus tumidus, young	11.5	--------	6.6	11.0	1.1	--------
Tropocyclops prasinus, female	--------	--------	32.0	4.4	--------	43.3
Tropocyclops prasinus, male	--------	--------	6.8	1.7	--------	13.4
Tropocyclops prasinus, young	9.6	1.4	4.2	0.9	0.4	18.4
Copepoda nauplii	26.0	2.2	21.1	2.1	0.8	4.2
Harpacticoid, undetermined	0.4	--------	--------	--------	0.8	--------
Diaphanosoma brachyurum, female	28.3	} 54.7	8.6	38.9		
Diaphanosoma brachyurum, young	6.2				--------	--------
Daphnia pulex obtusa, female	--------	--------	--------	1.9	17.8	12.4
Daphnia pulex obtusa, ephippial female	--------	--------	--------	0.2	0.8	--------
Daphnia pulex obtusa, young	--------	--------	--------	--------	16.7	8.3
Daphnia pulex obtusa, male	--------	--------	--------	--------	1.9	--------
	100.0	100.0	100.0	100.0	100.0	100.0

all the waters studied. It is not as abundant as *Neutrodiaptomus tumidus,* which, except for the upper pond of Matumine, is the most important component of all the lakelets studied. This species is endemic to these high mountain waters.

In Siron Mahayahen, Siron Mururoahu, and the upper pond of Matumine, *Tropocyclops prasinus* was represented only by young individuals, while in the other lakelets well-matured animals of both sexes were found. *Diaphanosoma brachyurum* is also an important component in these waters, but does not occur in the lakelets of the Matumine ridge, where it is replaced by *Daphnia pulex obtusa. Diaphanosoma paucispinosum,* which occurs in the warm lowland lakes, was never met with in these

high mountain lakes. Except in Myoto-ike, in which a small number of green algæ of the genus *Staurastrum* occurred, no visible phytoplankton was found.

Both the calanoid and the cyclopoid copepods in these high mountain waters are intensely carrot-red, as they are in the waters in the alpine regions of Honsyu, Hokkaido, and the Northern Kurile Islands. Such a phenomenon was not observed in any of the lowland lakes studied. I shall discuss this finding in greater detail later.

GENERAL CONSIDERATIONS

COMPOSITION OF THE PLANKTON FAUNA

Table 18 is based upon the series of collections made by our expeditions (compare also with Tables 19 and 20). The phytoplankton is omitted from this table because of its extreme paucity in all the lakes studied except Rigyo-ti.

With regard to the zoöplankton alone, as the writer has already pointed out in another paper, (31) there is a rather close resemblance among the lowland lakes studied. All of them are dominated by one species of Calanoida, *Mongolodiaptomus formosanus* or *M.* (?) *uénoi,* and by any one of the three species of Cyclopoida, *Mesocyclops leuckarti, Thermocyclops hyalinus,* and *T. taihokueneis.* The actual number of Cladocera collected in each lake is much smaller than that of either Copepoda or Rotatoria. In Zitugetu-tan, however, two species of Cladocera, namely, *Ceriodaphnia rigaudi* and *Bosmina longirostris,* are rather abundant, though inferior to the Copepoda, as can be seen in Table 19. The rotifers are numerically the richest species of the zoöplankton in the lakes studied. Ryuran-tan supports the richest variety of this group of animals, though rather few individuals of the respective species. Tables 19 and 20 show clearly this relationship.

It has been known that the rotifers, especially the *Brachionus* species, are abundant in alkaline waters. This is also true in Formosan lowland waters, the pH values of which were usually higher than 7, often as high as 8, and in which the rich variety of *Brachionus* was found.

The plankton of the high mountain lakelets differ greatly from those of the lowland waters. These lakelets in the high mountains support only one or two species of Cladocera and usually

TABLE 18.—*Distribution of zoöplankton in six Formosan lakes.*

	Zituget-utan.	Sang-otan.[d]	Kotohi.	Ryuran-tan.	Rigyo-ti.	Toapi-ike.
PROTOZOA:						
Difflugia acuminata Ehrenberg	--------	--------	--------	--------	(c)	--------
Arcella vulgaris Ehrenberg	--------	--------	--------	--------	(c)	--------
ROTATORIA:						
Polyarthra trigla Ehrenberg	--------	--------	(c)	(c)	(c)	--------
Trichocerca capucina (Wierz. et Zacharias)	--------	(c)	--------	(c)	(c)	(a)
Brachionus calyciflorus Pallas	(b)	(a b c)	(c)	--------	(a c)	--------
Brachionus angularis Gosse	--------	--------	--------	(c)	--------	--------
Brachionus forficula laevis Apstein	(c)	(a b c)	(c)	(b)	--------	--------
Brachionus angularis caudatus (Barris et Daday)	--------	--------	--------	(c)	--------	--------
Brachionus budapestensis Daday	--------	--------	--------	--------	(c)	--------
Schizocerca diversicornis Daday	(b)	(a b c)	(c)	(c)	--------	--------
Keratella cochlearis tecta Gosse	--------	--------	(c)	(c)	(c)	--------
Keratella valga tropica Apstein	(c)	(a b c)	(c)	(b c)	--------	(a)
Noteus militaris Ehrenberg	--------	--------	--------	(b)	--------	--------
Monostyla bulla Hudson	(a)	--------	--------	(b)	--------	--------
Filinia longiseta (Ehrenb.)	--------	--------	--------	(b c)	--------	(a)
Tetramastix opoliensis brevispina Ahlstrom	(c)	(b c)	--------	--------	--------	--------
Asplanchna priodonta Gosse	--------	(a b)	--------	--------	--------	--------
Pedalion mirum Hudson	(a b c)	(d)	--------	(c)	--------	--------
Pomphloyx complanata Gosse	(c)	(a)	--------	(c)	--------	--------
CLADOCERA:						
Diaphanosoma paucispinosum Brehm	--------	(a b c)	--------	(a c)	--------	(a)
Diaphanosoma brachyurum (Liévin)	(a b c)	(a b c)	--------	--------	--------	--------
Ceriodaphnia rigaudi Richard	(a b c)	(a b c)	--------	--------	--------	--------
Scapholeberis mucronata (O. F. Müller)	--------	--------	(c)	--------	--------	--------
Bosmina longirostris (O. F. M.)	(a b c)	(a)	(c)	--------	--------	--------
Alona rectangula G. O. Sars	(a)	--------	--------	--------	--------	--------
Alona intermedia G. O. Sars	--------	--------	(c)	--------	--------	--------
Alonella diaphana King	--------	--------	--------	(b)	--------	--------
Chydorus sp.	--------	--------	--------	--------	(c)	--------
COPEPODA:						
Mongolodiaptomus formosanus Kiefer	(a b c)	(a b c)	(c)	--------	--------	--------
?*M. uénoi* Kikuchi	--------	--------	--------	(b c)	--------	--------
Mesocyclops leuckarti (Claus)	(a b c)	(a b c)	--------	--------	--------	--------
Thermocyclops hyalinus (Rehberg)	--------	(a b c)	--------	--------	(a c)	--------
Thermocyclops taihokuensis (Harada)	--------	(a b c)	(c)	--------	--------	(a)

[a] Collection of April, 1935.
[b] Collection of July, 1935.
[c] Collection of January, 1937.
[d] Compare also with Harada. (7, 8)

two species of Copepoda, the latter two of which have never been found in the lowland lakes. This difference is primarily due to the low temperatures that prevail at high altitudes, most of the waters being less than 20°C. in July.

TABLE 19.—*Percentage composition of zoöplankton in six Formosan lakes.*

Group.	Zitugetu-tan.						Sango-tan.			Kotohi.	Ryuran-tan.		Rigyoti.		Toapi.
	(a)		(b)		(c)		(a)	(b)	(c)	(c)	(b)	(c)	(a)	(c)	(a)
	Z.	G.	Z.	G.	Z.	G.									
Protozoa														0.6	0.1
Rotatoria	12.5	63.1	1.1	1.2	10.3	10.2	9.5	29.9	15.5	51.3	1.8	51.1	0.1	13.4	1.7
Cladocera	19.4	10.9	21.7	29.2	27.3	29.2	15.6	14.3	10.8	1.5	5.9	47.3			6.5
Copepoda	68.1	26.0	77.2	69.6	62.4	60.5	74.9	55.5	73.7	47.2	91.1	1.6	99.9	86.0	91.7
Others								0.3			1.2				

[a] Collection of April, 1935. [b] Collection of July, 1935. [c] Collection of January, 1937.

TABLE 20.—*Summary of plankton fauna of Formosan lakes.*

Group.	Zitugetu-tan.	Sango-tan.	Kotohi.	Ryuran-tan.	Rigyo-ti.	Toapi-ike.	Mururoahu.	Mahayahen.	Myoto-ike.	Zigoku-ike.	Matumine (upper).	Matumine (lower).
Protozoa					2	1						
Rotatoria	8	9	6	13	5	3						
Cladocera	4	4	3	2	1	1	1	1	1	2	1	1
Copepoda	2	4	2	2	1	1	2	[a] 2	2	2	[a] 2	2
Decapoda (larva)				1								
Insecta (larva)		1										
Total	14	18	11	18	9	6	3	[a] 3	3	4	[a] 3	3

[a] Indicates one or more indeterminate species.

THE PLANKTON AND LAKE TYPE

The oxygen curves obtained in the lowland lakes including Zitugetu-tan are all of the typical form designated as eutrophic (text fig. 1) ; even in the first half of April the dissolved oxygen in the bottom water of these lakes diminishes greatly or becomes quite anaërobic. This is partly due to the very long stagnation of the lake water and to the warm bottom water, the minimum temperature of which is as high as 18°C. even in January (Rigyo-ti). According to the results of the temperature observations in January, 1937, the water of all these lakes completely circulates, but some of them are not aërated to the bottom, chiefly due to the very short winter stagnation period in these lakes, as is the case in certain deep subtropical lakes in southern Kyosyu.(38) The lakes here concerned may belong to the "incomplete" holomictic type.(38) No true meromictic lakes(4, 5) are present in Taiwan.

Concerning the important nutritive substances, particularly the nitrogen compounds, all the Formosan lakes considered in the present paper may belong to the polytype or mesotype according to Yoshimura's(36) scheme (Table 21). That is to say, the lakes concerned are, without exception, chemically eutrophic.(37) This finding agrees well with the suggestion presented by Ruttner(25) and Thienemann,(27) who concluded that the lakes in the Tropics would usually become eutrophic due to the rapid decomposition of organic matter in them caused by high temperatures.

With regard to the plankton production, there is distinct disharmony as to the chemical composition of the water in almost all lakes studied. In Rigyo-ti there was observed an enormous development of water bloom consisting of blue-green algæ and diatoms as early as January, while in the other lakes the phytoplankton was completely absent or formed a very slight water bloom. In the latter group of lakes the zoöplankton consists chiefly of Crustacea, especially of Copepoda, but is much less productive per unit volume of water than in the lakes of Honsyu or Hokkaido. It is reasonably supposed that in the water of Rigyo-ti such contents of nutritive substances ($N = 0.18$ mg, $P = 0.02$ mg per liter) may be expected to produce a water bloom when there are no other poisonous ions present. In the other lakes, though there are reasonable amounts of nutritive substances in the water, a slight development of water bloom was observed only in Zitugetu-tan.

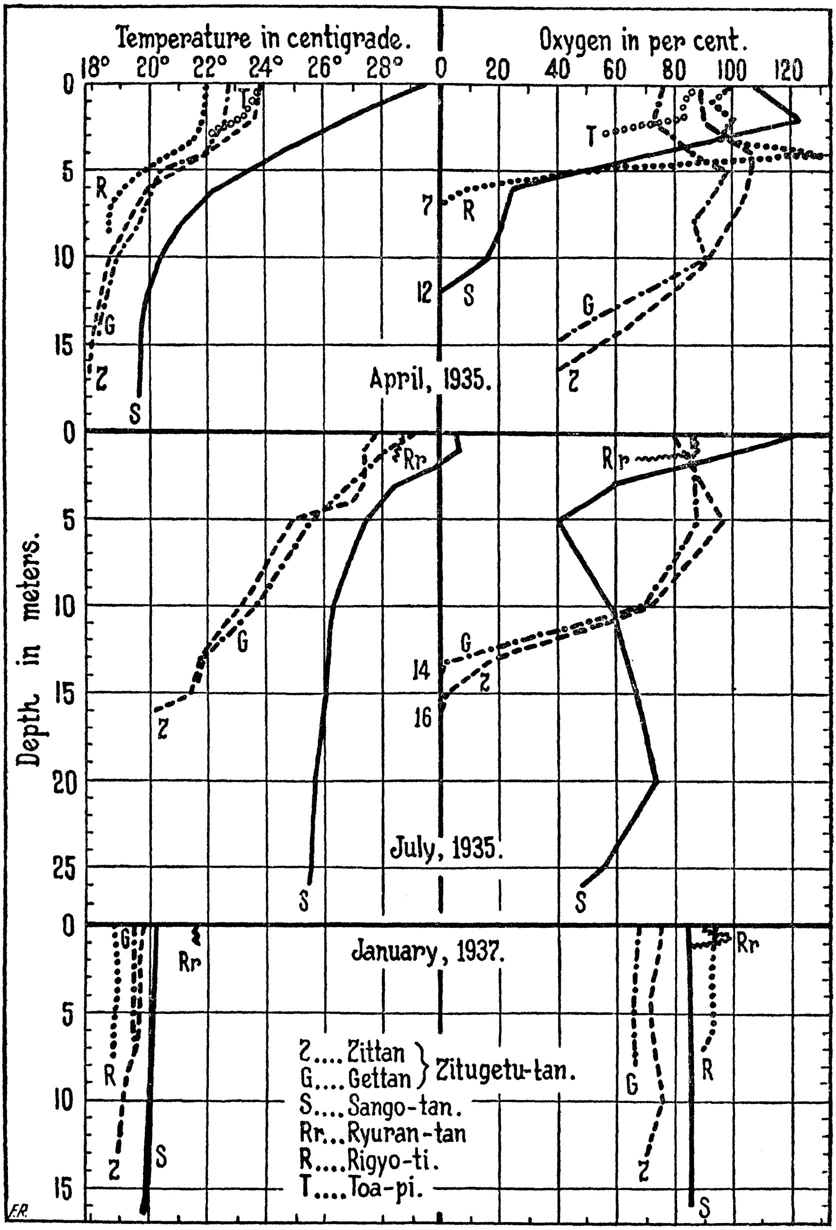

FIG. 1. Depth, temperature, and per cent of oxygen in six Formosan lakes at different times of the year.

TABLE 21.—*Physical and chemical analysis of lake waters of Formosa.*[a]

	Zitugetu-tan.		Sango-tan.		Rigyo-ti.		Toa-pi.
Depth, in meters	0	15	0	16	0	8.5	0
Color[b]	5	5	10	5	20	55	22
Electric conductivity, K 18 10^{-4} ohm^{-1}	3.49	3.61	2.98	3.56	0.83	0.86	4.29
Total solids	206.4	215.6	140.4	224.2	63.5	54.4	347.4
Na	11.3	8.7	----	7.2	3.1	1.3	16.8
Ca	44.3	50.5	35.8	41.5	13.2	14.4	69.6
Mg	20.1	15.8	14.0	16.2	1.4	----	0.6
Fe	0	0	0	0	0	0.5	0
Mn	0.05	----	----	0.25	0.05	0.7	0
SO_4	41.5	60.8	36.9	31.2	0.8	0	73.5
CO_2	55.6	55.8	51.0	63.0	17.6	19.5	51.0
Cl	0	0	2.9	3.6	1.9	2.0	3.4
SiO_2	8.9	9.1	8.8	9.8	2.6	3.3	10.7
MnO_4K consumed	27.8	20.8	----	15.0	16.2	13.7	12.8
N	0.19	0.24	0.34	0.15	0.18	0.39	0.255
P (soluble)	0	0	0	0	0.02	0	0.03

[a] Figures represent mg per liter of water. [b] Platinum-cobalt scale.

Table 21 shows that the water of the lakes concerned, except Rigyo-ti, contains a considerable amount of inorganic salts. There is considerably more sulphate than carbonate in Toa-pi, less in Sango-tan,[5] and the two are nearly of equal quantity in Zitugetu-tan. Such a disharmonic condition of ions may have the effect of restricting the phytoplankton production, but considerable amounts of suspended mineral matter and fine detritus in the water seem to be more effective.[6] The turbidity of the water, which is chiefly due to the flowing in of turbid streams, is usually too great for the free growth of phytoplankton, as will be seen from the transparencies determined by a Secchi white disc.

TABLE 22.—*Transparency of lakes, in meters.*

Lake.	April, 1935.	July, 1935.	January, 1937.
Zitugetu-tan	3.5–3.7	5.0	2.4–3.2
Sango-tan	1.2	0.5	1.2
Ryuran-tan	----	0.1	0.1
Rigyo-ti	1.8	----	2.9
Toa-pi	0.7	----	----

[5] The chemical constitution of the water of Sango-tan is discussed more in detail by Harada. (6)

[6] Since the present article was written, Hutchinson's important paper on the limnology of arid regions appeared, (9) in which it was pointed out that the action of the wind on the nutritive condition of desert lakes is important, and that in some of those lakes "the complete absence of living phytoplankton is due to the immense mass of mud in the waters."

Zitugetu-tan is the most transparent; in the other lakes the transparency is very low. Ryuran-tan is the most opaque, being markedly yellow. In these lakes a peculiar association of a large diaptomid (*Mongolodiaptomus*) and *Diaphanosoma* species is characteristic. These zoöplankton may feed on the bacterial and organic material in the suspended matter.

The characteristics of the bottom deposits agree well with the above results. Except for Zitugetu-tan and Rigyo-ti, the bottom deposits of the lakes studied are designated "Feindetritusgyttja" (Lundquist) consisting of considerable fine sand, especially in the case of Sango-tan. The bottom of Zitugetu-tan is covered with the gelatinous mass of a blue-green alga ("Bodenalgenäwja") containing a small quantity of diatoms. The bottom deposits of Rigyo-ti are, on the contrary, in harmony with its production of phytoplankton, which is regarded as "Algengyttja," consisting of amorphous blue-green algæ and of rich diatoms.

The high mountain lakelets differ essentially from the lakes in the low plains, not merely physiographically but biologically. The waters of Myoto-ike and Zigoku-ike are peculiar in that they contain rather large amounts of sodium and chloride, while the upper pond of Matumine, Siron Mahayahen, and Siron Muruoahu contains considerable amounts of humic substance which gives the water a dark-brown color. In their dystrophic condition they appear to be similar to those distributed in high altitudes of middle Honsyu and the northern parts of the Japanese Islands. The humus formation in a warm region such as Formosa too may be commensurate with the increase of altitude, according to Jenny's(11) conclusion that humus content decreases regionally from $\frac{1}{2}$ to $\frac{1}{3}$ with every 10°C. increase. One or two species of Copepoda or of Cladocera or both are the only zoöplankton in these waters, though quantitatively abundant.

Summarizing the data discussed above, the lakes and lakelets studied may be divided into the following groups:

A. Eutrophic Lowland Lakes.

Aa. Eutrophic type without an intense development of water bloom, including Zitugetu-tan, Sango-tan, Kotohi dam, Ryuran-tan, and Toa-pi. These lakes contain considerable amounts of salts, especially sulphate or carbonate of lime (gypsotrophic phase). Zoöplankton characterized by Copepoda and Cladocera. Bottom deposits often contain considerable amounts of fine sand.

Ab. Eutrophic type with an enormous appearance of water bloom (ortho-eutrophic), including Rigyo-ti. Zoöplankton very scarce; blue-green algæ and diatoms dominant. Bottom deposit characterized as "Algengyttja," rich in diatoms.

B. Mesotrophic high mountain lakelets:

Ba. Polyhumus type including Siron Mururoahu, Siron Mahayahen, the upper pond of Matumine; water coffee brown; characterized by intensely red copepods and by one or two species of Cladocera.

Bb. Meso- or oligohumus type, including Myoto-ike, Zigoku-ike, and the lower pond of Matumine; water dark greenish brown or brown; the plankton does not differ essentially from that of Ba.

The lakes lying in the low plains and even as high as 740 meters above the sea (Zitugetu-tan) are without exception in a eutrophic condition, while those in the high mountain lakelets are in a eutrophic condition of less advanced stages or dystrophic.

OCCURRENCE OF RED COPEPODS IN FORMOSAN HIGH MOUNTAIN WATERS

Since Zschokke (40) noticed the occurrence of red copepods in lakes of high altitudes, the red coloring phenomenon of copepods called "Alpine Rotfärbung"(40) has been discussed by many ecologists for many years.[7] In the high mountain lakelets of Formosa studied, red copepods also occur very abundantly, as stated above. This phenomenon is also observed in many waters in the high altitudes of middle Honsyu, as well as in the northern parts of Japan.

The calanoid *Acanthodiaptomus yamanacensis* (Brehm) is the only representative red copepod inhabiting the waters in the districts south of Hokkaido, but in the northern Kurile Islands most of the species of Copepoda, including the above calanoid, living in the shallow bodies of waters showed intensely red coloring.(20) The fact that the red coloring of copepods is much more intense in the north or in high altitudes suggests the lowering of the water temperature of their habitats as the most important factor causing the red coloring, as suggested by Zschokke (40) and other authors succeeding him. *Acanthodiaptomus yamanacensis* shows, however, a red color in certain volcanic lakes in the low plains of Honsyu and Hokkaido, as also noticed by Elster(3) and Valkanov,(34) who found red copepods in the waters in the forest zone in Europe. On the other hand, several ecologists have noticed the relation between the red color of copepods and the phytoplankton. In this connection we owe much to Blaas,(1, 2) who concluded that the red color of copepods was due to the nature of the water in which they live as well as

[7] For the references to this subject, see Pesta.(24)

to the richness of nannoplankton, especially the minute algæ which are a source of food for copepods.

Acanthodiaptomus yamanacensis is a eurythermal calanoid widely distributed throughout the Japanese Islands, from the Kuriles to southern Kyusyu, Korea, as well as in Manchoukuo and Kamtchatka. It shows a red color in waters that are weakly or strongly acid (pH 4 to 6.8) and are mostly oligotrophic or dystrophic rather than eutrophic; in alkaline waters it usually shows no red color. A similar result has been obtained in the Formosan high mountain lakes, the waters of which are weakly acid (pH lower than 6, see Table 14), red copepods (*Neutrodiaptomus tumidus* and *Tropocyclops prasinus*) being found in them abundantly. It seems therefore that the acidity of the water is an important cause of red color in copepods.

Uéno et al.(29) isolated three kinds of carotinoid pigments, β-carotin ($C_{40}H_{56}$), astacin ($C_{40}H_{48}O_4$), and a new carotinoid, from the body of *Acanthodiaptomus yamanacensis* of Lake Sikotu, Hokkaido. Astacin, which is an acid carotene distributed in many Crustacea,(17, 39) is the most important constituent of the red color of this calanoid. Astacin is produced in the copepodean body by the oxydation of β-carotin, which is most widely distributed in the plant world. According to this view it is quite possible that the nannoplankton algæ serve as an important source of β-carotin, and that the carotinoid pigments thus formed are deposited in the fatty parts of the body due to their fat-soluble nature, and in consequence give an intense red color to the organisms. When *Acanthodiaptomus yamanacensis* lives in acid water the color waxes of astacin may remain stable in the body, but when it inhabits an alkaline water the pigments may dissolve out of the body by saponification because of its acid nature. If this be so, the red color of copepods has but an ecological significance; that is, the copepod gets energy produced in the process of oxidizing β-carotin to astacin in its body, so that the pigment may be a useless substance for the organism. More detailed experimental studies are needed, however, to clear up his puzzle.

The habitats of intensely red copepods in Formosa are cold and acid waters, as is the case in Japan, north of this island. Recently Hutchinson (9, p. 143) found "the smaller intensely red copepods" inhabiting the extremely alkaline water (pH 9) of Tso Moriri of the Indian Tibet.

SUMMARY

1. Plankton of six lowland lakes and six high mountain lakelets in Taiwan, Formosa, is reported, together with physical and chemical observations on these bodies of water.

2. Phytoplankton is very scarce, an enormous development of water bloom being observed in only one lake, while these lakes are in general to be regarded as eutrophic. The zoöplankton consists chiefly of Copepoda and Cladocera, of which the former are usually dominant in the lakes.

3. It is suggested that the presence of considerable amounts of suspended matter and of dissolved salts in the waters would probably produce a marked effect on the production of plankton, especially on the growth of phytoplankton.

4. The high mountain lakelets differ greatly from the lakes in the lowland as to the nature of the waters and as to the plankton. The zoöplankton consists of only one or two species of either Copepoda or Cladocera, which belong to the species different from those in the lowland lakes.

5. Intensely red copepods, due probably to astacin, occur in the high mountain lakelets, where the waters are usually acid, as is also the case in corresponding Japanese lakes and lakelets.

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ILLUSTRATIONS

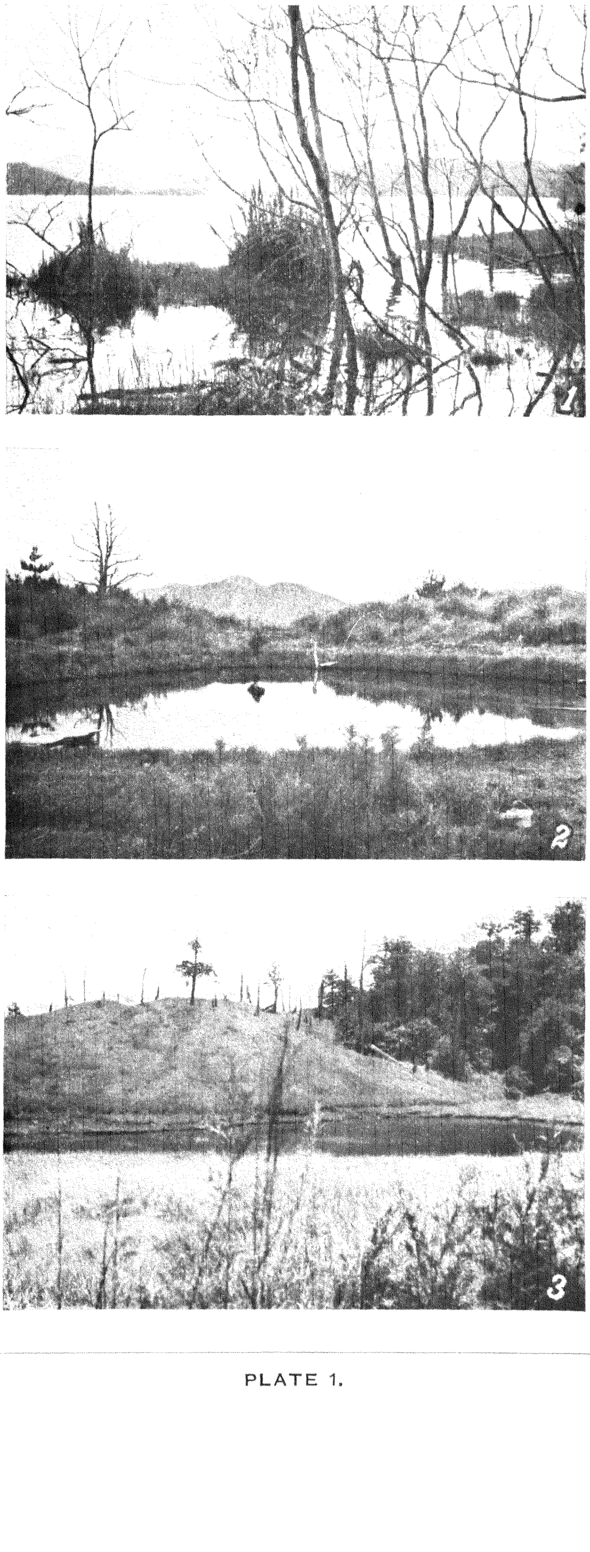

PLATE 1.

FISH-FRY INDUSTRIES OF THE PHILIPPINES

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TWO PLATES AND NINE TEXT FIGURES

The abundance of marine as well as fresh-water species of fish in the Philippines accounts for the presence of numerous kinds of pelagic and demersal fish eggs and larvæ in our waters. The coastal waters and the mouths of rivers, as well as tidal creeks where numerous species of fish spawn or where the juvenile stages of aquatic life drift from the deep-water breeding places, are especially rich in fish eggs and fry. The breeding or spawning activities of most species of our food fishes are periodic, so that the occurrence in large numbers of fish fry or larvæ is also periodic. Consequently the commercial utilization of fish fry in the Philippines is generally confined to certain seasons of the year.

For the last few years the Fish and Game Administration has undertaken the survey of fishing grounds for larval fishes; like bañgos fry, goby fry, and siganid fry. Although the commercial exploitation of larval fishes is believed by many to have but little effect on the abundance or scarcity of fish, yet our observation reveals that the wholesale capture of larval fishes both for stocking fishponds and for the manufacture of *bagoong* and other forms of preserved fishery product is partly responsible for the obvious depletion of many of our fishing banks.

The larvæ of the bañgos, *Chanos chanos* Forskål, have, from time immemorial, been the subject of great commercial interest to fishpond operators. In fact, the bañgos-fry industry is easily worth 1,000,000 pesos annually to the municipalities of the Philippines that border sandy seacoasts.

The larvæ of other species of fish which are of commercial importance are also dealt with in this paper, as well as regulatory and remedial measures for the protection of these larvæ and for the rehabilitation of depleted fisheries.

MILKFISH-FRY (BAÑGOS) FISHERIES

The study of the bañgos-fry fisheries of northwestern Luzon was undertaken from March to June, 1936, primarily to deter-

mine the conditions and importance of the fisheries, and secondarily, to recommend measures for their improvement.

With the increasing number of bañgos-fishpond operators in the Visayan Islands, especially Negros and Panay, there is a tendency of cutting the supply of bañgos fry to Manila from that region. The Formosan Government is also trying to import from the Philippines bañgos fry of a certain size for use as live bait in tuna fishing.

The yearly demand for bañgos fry by bañgos-fishpond operators around Manila Bay (in Rizal, Bulacan, Pampanga, Bataan, Pangasinan, La Union, and Zambales Provinces, where the investment in fishponds amounts to over 50,000,000 pesos) has led to the extensive development of the bañgos-fry industry in Ilocos Norte, Ilocos Sur, La Union, Batangas, Cebu, Antique, and Negros Provinces.

The catching of bañgos fry from March to June is seasonal, like that of catching goby fry. During this period the milkfish, *Chanos chanos*, spawns in waters not far from sheltered bays, coves, and gulfs, whence immense numbers of fry eventually drift towards shallow sandy coasts. The bañgos is one of the most prolific of fishes; a ripe female may have from 3,000,000 to 5,000,000 ova, depending upon its size.

The small transparent bañgos fry swim in schools. They enter rivers, estuaries, and tidal creeks with advancing high tide.

Fry of other fishes that go in schools with the bañgos fry from March to June are *Ambassis* spp. (*dañgat* or *begsang*), *Mugil* spp. (*aligasin* or *sarabab*), *Therapon cancellatus* (Cuv. & Val.) (*bagaong* or *baraongan*), *Sphyræna obtusata* (Cuv. & Val.) (*babayo*), Soleidæ (*dadali*); *Scatophagus argus* (Linnæus) (*malaga*), *Megalops cyprinoides* (Broussonet) (*buan-buan* or *bulan-bulan*), *Sillago sihama* (Forskål) (*asohos* or *osohos*), *Leiognathus caballus* (Cuv. & Val.) (*sapsap*), *Amphacanthus virgatus* (Cuv. & Val.) (*kuyog, yomoyobyob* or *kuing*), *Caranx ignobilis* (Forskål) (*pepikat* or *maliputo*), *Caranx marginatus* Gill (*muslo*).

Larval stages of shrimps and prawns, and zœa and young stages of crabs such as *alimañgo, katang,* and *alimasag* are also included in the catch. The destruction of larval crustaceans also causes the depletion of the crustacean fauna of a given region.

Bañgos-fry catchers or collectors throw away larvæ of other fishes that are caught with the bañgos fry. This practice is against the policy of the Fish and Game Administration of conservation and utilization of fish larvæ for stocking tidal creeks, rivers, and lakes. If the bañgos-fry fishermen return the undesirable fry back to the sea or farther up the stream or creeks, the same fry will be caught in their traps, because tides usually bring these animals back to the shores. Another way in which other marine larval fishes are wasted is by the pollution of some tidal creeks or estuaries due to the retting of maguey leaves in places where retting is done on a large scale, as in the Ilocos region. Fishes, crustaceans, and mollusks do not survive in polluted waters and it would be of no value for the bañgos-fry collectors to liberate other larval fish in such places.

The importance of the bañgos-fry industry of the coastal towns of the Ilocos and the Batangas, Cebu, and Negros Provinces.— In Ilocos Norte Province bañgos fry are caught along the coast, at the mouths of Laoag, Puyupuyan, Bacarra, Caaoacan, Mangato, and Callaguip Rivers, and at the mouths of the small tidal creeks of the municipalities of Burgos and Badoc.

In 1934 the income from bañgos-fry leases was 2,225.25 pesos;[1] in 1935, 2,300.90 pesos, and in 1936, 3,757 pesos (Table 1), showing an increase of 1,456.10 pesos, or 63 per cent. It has been estimated that from March to June, 1936, around 14,638,000 bañgos fry, or 7,319 jars, were caught in Ilocos Norte Province. This quantity was valued at approximately 36,595 pesos (Table 2).

TABLE 1.—*Fees from bañgos-fry leases in Ilocos Norte Province.*

Municipality.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Bangui	----------	60.00	----------
Burgos	150.25	102.40	100.00
Pasuquin	205.00	205.00	550.00
Bacarra	60.00	120.00	410.00
Laoag	700.00	600.00	905.00
Paoay	1,110.00	1,130.00	1,625.00
Badoc	----------	83.50	167.00
Total	2,225.25	2,300.90	3,757.00

[1] One peso equals 50 cents United States currency.

TABLE 2.—*Approximate number and value of jars of bañgos fry caught from March to June, 1936, in Ilocos Norte Province.*

Town.	Fishing locality.	Jars.	Value.
			Pesos.
Burgos	Buran-Bubon	97	485.00
Pasuquin	Puyupuyan River and marine shores	521	2,605.00
Bacarra	Bacarra River and marine shores	391	1,955.00
Laoag	Caoacan River, Laoag River, Mangato River, marine shores	3,500	17,500.00
Paoay	Callaguip River and marine shores	2,500	12,500.00
Currimao	Gaang shores	60	300.00
Badoc	Gabbot marine shores Lugo-Pagsanaan	250	1,350.00
	Total	7,319	36,595.00

In Ilocos Sur Province bañgos fry are caught along the coasts, tidal creeks, estuaries and mouths of rivers of nearly all the seacoast towns. Here the fees derived from the lease of bañgos-fry grounds in 1934 amounted to 5,938 pesos; in 1935, to 9,761 pesos, with an increase of 3,823 pesos, or 64 per cent; in 1936 the fee was 12,975.20 pesos, or 34 per cent more than that in 1935 (Table 3). The significant increase in fees is due to the very keen competition among bañgos-fry dealers in offering high bids to obtain good bañgos-fry grounds. The approximate numbers of jars of bañgos fry caught from March to June, 1936, was 12,460, valued at 62,300 pesos (Table 4).

TABLE 3.—*Fees from bañgos-fry leases, Ilocos Sur Province.*

Municipality.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Sinait	350.00	410.00	951.99
Cabugao	1,010.00	1,010.00	1,010.00
Lapog	60.00	129.00	156.00
Magsingal	----------	800.00	790.00
Santo Domingo	500.00	1,540.00	2,621.21
Santa Catalina	30.00	30.00	----------
Caoayan	150.00	155.00	335.00
Santa	117.00	55.00	----------
Narvacan	800.00	1,850.00	2,501.00
Santa Maria	1,197.00	1,676.00	2,500.00
San Esteban	----------	----------	215.00
Santiago	----------	----------	315.00
Candon	570.00	700.00	700.00
Santa Lucia	----------	----------	800.00
Santa Cruz	1,154.00	1,406.00	----------
Total	5,938.00	9,761.00	12,975.20

TABLE 4.—*Approximate number and value of jars of bañgos fry caught from March to June, 1936, in Ilocos Sur Province.*

Town.	Fishing locality.	Jars.	Value.
			Pesos.
Sinait	Dadalaquiten, Teppeng, Pugos, Cabangtalan	908	4,540.00
Cabugao	Pugos, Daclapan	963	4,815.00
Lapog	Nagcabibian, Sabangan Buaya, Saoang, Quisit	200	1,000.00
Magsingal	Marine shores	754	3,770.00
Santo Domingo	Namonoan tidal creek and marine shores	2,500	12,500.00
Caoayan	Pandan shores, Bagoc tidal creek	358	1,790.00
Santa	Sabangan Niog, Agayayos		
Narvacan	Marine shores, Paratong	2,386	11,930.00
Santa Maria	Biao, Suso tidal creek, and marine shores	2,385	11,925.00
San Esteban	Marine shores	200	1,000.00
Santiago	Marine shores	300	1,500.00
Candon	Paypayad, Tamorong	671	3,355.00
Santa Lucia	Marine shores	835	4,175.00
Santa Cruz	Davao River, Dile River, Marine shores		
	Total	12,460	62,300.00

In La Union Province bañgos fry are caught at Darigayos River at Balaoan; Marigay River, and Ballogo barrio of Bacnotan; marine shores of San Fernando; marine shores and estuaries of Bauang; and shores of Santo Rosario and Santa Lucia of Ariñgay. Other bañgos-fry grounds of La Union Province have not been leased, due to high fees. In this province the collection for bañgos-fry leases in 1934 was 4,086 pesos; in 1935, 4,424 pesos. The fee for 1936 increased to 6,869.85 pesos (Table 5). The estimated number of jars of bañgos fry caught in 1935 was around 8,500, valued at 42,000 pesos.

TABLE 5.—*Fees from bañgos-fry leases in La Union Province.*

Municipality.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Bangar			680.00
Bacnotan	770.00	600.00	908.98
Luna			900.00
Balaoan		720.00	751.00
San Juan			970.37
San Fernando	2,110.00	1,521.00	1,627.50
Bauang	500.00	812.00	855.00
Cava			25.00
Aringay	706.00	771.00	152.00
Total	4,086.00	4,424.00	6,869.85

The revenue derived by the Ilocos provinces from bañgos-fry ground leases in 1934 amounted to 12,249.25 pesos; in 1935, to 16,486.40 pesos, and in 1936, to 23,602.06 pesos (Table 6). The value of bañgos fry caught annually in northwestern Luzon and sold in these places is estimated at not less than 140,000 pesos.

TABLE 6.—*Fees from bañgos-fry leases in the Ilocos provinces.*

Province.	1934.	1935.	1936.
	Pesos.	*Pesos.*	*Pesos.*
Ilocos Norte	2,225.25	2,300.90	3,757.00
Ilocos Sur	5,938.00	9,761.50	12,975.20
La Union	4,086.00	4,424.00	6,869.85
Total	12,249.25	16,486.40	23,602.05

In Batangas Province the catching of bañgos fry is also an important industry from April to July. The annual fee derived from the leasing of bañgos-fry grounds amounts to about 50,000 pesos. Bañgos fry begin to appear in Balayan Bay and its contiguous waters in March and disappear in July, but the height of the season is in April, May, and June. The season of abundance of bañgos fry in the coastal waters from Nasugbu to Calatagan, Batangas, is similar to that of Balayan Bay.

Table 7 gives the value of the partial count of fry caught during the bañgos-fry season from 1930 to 1935, inclusive, showing a yearly average catch of 4,197,000 bañgos fry, valued at 4,197 pesos.

TABLE 7.—*Bañgos fry in coastal waters from Nasugbu to Calatagan, Batangas Province.*

Period.	Number of fry.	Value at 10 centavos per 100.
		Pesos.
April–July, 1930	2,022,000	2,022.00
April–June, 1931	4,352,000	4,352.00
April–June, 1932	3,208,000	3,208.00
April–July, 1933	5,696,000	5,696.00
April–July, 1934	2,382,000	2,382.00
April–June, 1935	6,502,000	6,502.00
Average per year	4,197,000	4,197.00

Table 8 shows a partial count of the bañgos fry caught at Balayan Bay within the vicinity of Lemery, Batangas Province.

TABLE 8.—*Partial count of bañgos fry collected from Balayan Bay within the Lemery municipality during 1935.*

Period.	Number of fry.	Value at 10 centavos per 100.
1935		*Pesos.*
April 10–30	740,315	740.32
May 1–28	2,288,320	2,288.32
June 7–17	953,490	953.49
Total	3,982,125	3,982.13

Table 9 shows a partial count of the bañgos fry collected from the Palanas tidal waters of Lemery, Batangas Province.

TABLE 9.—*Partial count of the bañgos fry collected from Palanas tidal waters, Lemery, Batangas Province, during 1935.*

Period.	Number of fry.	Value at 10 centavos per 100.
1935		*Pesos.*
April 10–30	27,700	27.70
May 1–22	41,900	41.90
June 11–15	23,500	23.50
Total	93,100	93.10

The fisheries of Lake Taal and Pansipit River have apparently decreased, due partly to the injudicious destruction of larvæ, fry, and fingerlings of fishes other than the bañgos fry migrating from Balayan Bay to Taal Lake and Pansipit River.

Manila gets its supply of bañgos fry from Cebu, Panay, and Negros. At present no records are available of the quantity and value of the bañgos fry caught in the bañgos-fry grounds of the Visayas.

The conditions and system of leasing and working out bañgos-fry concessions.—Any municipality in any of the Ilocos provinces or in any regions of the Philippines having good bañgos breeding grounds usually leases annually from March to June to the highest bidder the exclusive privilege of catching bañgos fry. Usually the contracts of lease are made after the bids for the bañgos-fry grounds are made, in December or January.

The reasons for the practice of auctioning off bañgos-fry grounds of the municipalities are as follows: (*a*) It is the most

effective and surest source of higher revenue; if the fishing appliances for bañgos fry are licensed in accordance with fixed minimum rates the income is less; (b) there is union among bañgos-fry fishers of each concession, so that a concessioner can assure the bañgos-fishpond owners an adequate supply of bañgos fry.

Although the reasons for the continuation of the lease of bañgos-fry grounds are good, there are also considerable defects in this practice. In the first place, it enables a few individuals to monopolize the taking of fry. Local fishermen are deprived of the privilege of catching bañgos fry in season, because of the well-organized union of bañgos-fry dealers who recruit their bañgos-fry catchers from Pangasinan and Pampanga provinces.

The bañgos-fry industry is monopolized by a few bañgos-fry dealers from Pampanga, Pangasinan, and Rizal provinces, each having a crew of 10 to 20 persons in each of their bañgos-fry concessions. Each fisherman is paid a monthly salary of 15 to 20 pesos, with free board and lodging. The head of the crew supervises the building of the bañgos-fry shed, the constructing of the saplar, the fixing of the nets and jars, the catching of bañgos fry, and the preparation of bañgos-fry jars for shipment. A fisherman in the fishing barrio may catch bañgos fry in a bañgos-fry concession on condition that he receives one-half of the value of his catch.

Methods of catching bañgos fry.—Three methods which have been introduced by the Tagalogs and Pampangeños in northwestern Luzon are used in catching bañgos fry; namely, *saplad* or *saplar*, *sayod*, and *sagap*.

The saplad, or saplar (Plate 1, fig. 1), is employed at the mouths of rivers, estuaries, and tidal creeks. The gear consists of a V-shaped barricade of crushed bamboo (*tinidtid*), which is set firmly at the bottom ground. At the point of intersection of the tinidtid walls is a gate through which the fry pass into the saplar proper, a half-hoop net of sinamay 1.5 meters long and 2 feet wide attached by means of strings to two parallel bamboo poles, facing down-stream. The saplar is set in shallow water about a meter high. A number of saplar might be used to cover the entire width of a tidal creek.

The sayod is a seine made of coarse sinamay, about 1.5 meters wide and 5 meters long. Two fishermen, one at each end of the sayod, drag the device along the shore until a great number of fry are caught.

The sagap (Plate 1, fig. 3) is similar to the *bintol* for catching shrimps. It is a rectangular sinamay net 1 meter wide and 2 meters long, with sinamay walls. It is mounted on two crossed bamboo slats, each 3 meters long, 2 inches wide, and 0.5 inch thick. It also is operated by two fishermen along shores and along margins of mouths of rivers.

Methods of counting and acclimatizing the fry.—The fry are dipped from the saplad, sayod, or sagap with a basin; debris are removed with a small bamboo broom. When fry of other fishes are numerous, it is necessary to sort out the bañgos fry with an open-top cylinder of wire netting, 11 inches high, 6 inches in diameter, and a mesh of 1.5 square millimeters, large enough for the tiny bañgos fry to pass through. When the sieve is used, it is partly immersed in a large basin of water where the fry from a smaller basin are poured into the sieve. Fry of other fishes that remain in the sieve are discarded as stated elsewhere.

The method of counting the fry is a tiresome operation. The counters use the *palayok* system. They have on hand one thousand pebbles or small shells as counters. One man counts the fry in a small bowl or clam shell (*cappo*) which he uses for dipping out the fry from one container into another. After each count he calls out the number of fry in the dipper. Another man separates a corresponding number in counters. This process is continued until a thousand is counted. The density of one thousand fry in a basin is used as a basis for the other thousands of fry which are put in jars. A jar of 20- to 30-liter capacity usually holds from 2,000 to 3,000 fry.

The water in the jars of fry which is at first salty is gradually diluted with fresh water so that the fry can be kept in the jars a longer time, and the use of sea water in transit avoided in case the fry are sold to buyers far away from the coast. Then the jars are covered with leaf sheaths of betel palms ready for transit. The bañgos fry cannot stand more than two weeks without feeding, so the jars of bañgos fry must reach the rearing ponds in the Central Luzon provinces before the end of two weeks.

The mortality of the bañgos fry in the jars while in transit is from 5 per cent to 20 per cent, depending upon the distance. Mortality is due to: (*a*) Overcrowding and insufficient oxygen in the water; (*b*) the lack of food for the fry as the embryonic yolk is gradually absorbed in the process of postlarval develop-

ment, when fins, body, and head regions develop; (*c*) the presence of protozoan fish parasites that may attach themselves to the fins, body, and vent of the fry, gradually reducing its vitality and effecting its death; (*d*) long transit generally weakens bañgos fry.

The price of bañgos fry in the Ilocos provinces, Pangasinan Province, and the central provinces varies according to the catch of each month. In March the price of one jar of 2,500 to 3,000 bañgos fry is from 2.50 pesos to 3 pesos. In April the same number of bañgos fry brings 3 pesos to 3.50 pesos per jar. In May, the height of the season, when the catch is greater, the price ranges from 2 pesos to 2.60 pesos per jar of fry. In June and July, when the catch is less, the price goes up to from 3.50 pesos to 5 pesos per jar of 2,500 to 3,000 bañgos fry.

Natural factors, such as occasional floods during the rainy season, may destroy the bañgos fishponds of Pangasinan, La Union, and other provinces, liberating thousands of yearlings or 6-month-old bañgos. In the following bañgos-fry season there is a tendency for the price of bañgos fry to rise, due to increased demand. The price of one jar at such times is from 7.50 pesos to 10 pesos, and even as high as 15 pesos or 25 pesos a jar of 2,000 to 3,000 fry. In the succeeding bañgos-fry seasons there may also be a corresponding decrease in the prices of bañgos fry, due to the increase of the bañgos breeders in the sea.

Bañgos-fry dealers and fishpond owners of Bulacan, Pampanga, Bataan, and Pangasinan provinces, usually buy the fry from northwestern Luzon and the Visayas, and rear them in the fry-rearing ponds.

Recommendations.—The fry of the migratory fishes that are caught with the bañgos fry should be collected and planted farther up in tidal creeks or rivers.

The retting and washing of maguey fiber must be confined to the shores where water pollution is absent. It should be prohibited in fish nurseries, such as tidal creeks, estuaries, and rivers.

The saplar, when in use, should not block completely a stream, estuary, tidal creek, or the mouth of a river; at least one-third of the mouth of a stream, river, estuary, or tidal creek must be left open for the passage of migratory fishes, boats, rafts, and launches.

The lessees should keep a record of the quantity of bañgos fry caught (number of jars) from March to June and submit

a report after each season to the municipal mayor who in turn will submit such records to the Fish and Game Administration for statistical purposes.

A durable and cheap container should be made and tried in the transportation of fish fry. The earthen jar (palayok) is breakable, expensive, and delicate for shipment.

Life history studies should be made during the bañgos-fry season. Very little is known of the spawning and breeding habits of bañgos.

GOBY-FRY (IPON) FISHERY

The investigation of the ipon fisheries of northern Luzon was started in November, 1934, and continued in 1935. The primary object of the work was to look into the possibilities of regulating the fisheries in order to protect the industry from depletion. Like other natural resources regularly drawn upon by man, the ipon fishery is subject to over-fishing. In fact, the ipon fishery, including in its activities only the fry of migratory gobies and eleotrids, is more intensely affected by overfishing than the fishery of adult fish.

For the purpose of formulating regulatory measures for the conservation and protection of the ipon fisheries of northern Luzon, the fishery devices used in catching the ipon, the volume of the upstream migration of the fry, and certain aspects of the biology of the fish that supply the ipon were studied.

The goby fry are the larval stages of various species of gobies, known as ipon in Iloko. The known sources of ipon of northern Luzon are *Chonophorus melanocephalus* (Bleeker) (*bukto* Ilk.); *Chonophorus ocellaries* (Broussonet) (*bunog* Ilk.); *Eleotris melanosoma* (Bleeker) (*virot* Ilk.); *Glossogobius celebius* (Cuvier and Valenciennes) (*balla* Ilk.); *Ophiocara aparos* (Bleeker) (*dulong* Ilk.); *Rhyacichthys asparo* (Kuhl and van Hasselt) (*campa* Ilk.); *Sicyopterus lacrymosus* (Herre) (*paliling* Ilk.).

From June to November the adult gobies descend periodically to the sea to spawn. The occasional floods in the river systems of northern Luzon during the rainy seasons destroy the hiding places upstream of the gobies. Thus the river currents carry the gobies away to the sea periodically, the latter stopping wherever they can to feed. During this down-stream migration of the sexually mature gobies they are sometimes caught with the *kitang* (set lines), *palamag* (bombon or bunches of debris submerged in water), and *cubong-cubong* (bamboo tubes).

About 40 per cent of the sexually mature gobies are caught from June to August, while the fishermen engaged in this capture are very few in comparison with the number of fishermen catching goby fry.

The spawning habits of the larger species of gobies are not definitely known. Herre (1927) stated that the eggs of *Glossogobius giurus* (*bia* Tag., *balla* Ilk.) are laid underneath rocks near the mouths of rivers, where they are affected by tides. When sexually mature the bia is about 22 to 144 millimeters long; *Chonophorus melanocephalus*, 20 to 120; *Eleotris melanosoma*, 20 to 100.

The breeding habits of the minute lake-dwelling gobies, *Mirogobius lacustris* Herre and *Mirogobius stellatus* Herre, have been studied. These species of gobies are sexually mature at a length of about 2.5 centimeters. The ripe female extrudes the eggs singly. The eggs are about a millimeter in diameter. They adhere to aquatic plants or other objects by means of external threads. They are fertilized by the male either when they are still attached to the vent of the female or when they are attached to aquatic plants. The embryo develops in three days and the eggs hatch on the fourth or fifth day, depending upon the temperature.

Although our knowledge of the breeding habits of large species of gobies is very meager, we know from repeated observation the periodic appearance of vast shoals of ipon during high tides nine days following the full moon of each month from September to February, and extending to even as late as March along the Ilocos coastal regions and the northern coast of Cagayan Province. The ipon are brought in by the incoming high tide, going in schools as they enter the mouths of rivers.

In the Ilocos regions there are six so-called "runs" of ipon, known in Iloko as *apta,* for September; *pasaran* in October; *papait* in November; *lumaladec* in December; *paturay* in January, and *salsalput* in February.

The parr marks of the ipon of each of the runs indicate that they are the heterogenous larval stages of the bukto, bunog, balla, campa, and paliling. As the ipon migrates, it feeds on algæ or plankton. Then appear the changes in color, from transparent white to the characteristic parr marks or cross bars and pigments of the adult. The ipon which are now usually 2.5 centimeters long develop into various species of gobies ranging in length from 8 to 25 centimeters.

Methods for catching goby fry.—Fishing starts along the coast as soon as the goby fry are sighted with the incoming high tide. Catching ipon with the nets along the coast and at river mouths lasts from one to four days, while farther upstream fishing with barricade traps may last for a week.

The fishing appliances used in catching the goby fry along the seashore are various types of ipon nets or seines, known in Iloko as *daclis, tangar, garamgam,* and *tuad.* Along the rivers varied styles of barricade traps of bobo and hoop nets are the most effective devices used in catching the ipon in their migration farther up the stream. These traps are known also as *pamoboan, piñgi, sarep, pataya, pasalugqui, lel-len, paculod, paed, paayas, padait, pamalibtocan, burayoc,* and *etter.* The simplest gear is known as *caput.*

The seine, *daclis de ipon,* is made of coarse cotton cloth or sinamay. The conical bag of the seine is about 20 meters long, its left and right wings each 25 meters long, 3 meters at their widest portion, and 2 meters wide at their ends. The accessory parts of the wings are wooden or bamboo floats 4 inches long and 3 inches in diameter, attached 1 foot apart along the corkline, and the earthen weights, 3 inches long and 3 inches in diameter, which are strung to the bottom line or ground rope, 1 foot apart. The bamboo brails are tied to the wing bridle about a meter away from the ends of the wings. The free ends of the corkline and the ground rope form the wing bridles to which are joined the 200-meter pull ropes.

The *chinchorro* (daclis de ipon) is operated along gradually shelving shores and at the mouths of rivers. When enclosing a school of ipon, small boats (viray) or large bamboo rafts are necessary to accommodate a part of the crew and the ipon nets. As soon as the crew of the ipon net and boat have thrown the daclis de ipon in a semicircular manner along the beach or at the mouth of the river, the pull ropes are pulled by several persons. The wings of the nets are dragged slowly in such a way as to concentrate the catch into the bag of the seine. Fifty to seventy-five persons are needed in the operation of the daclis de ipon. A single haul of an ipon net catches from 2 to 8 cavanes during the height of the season. (Plate 2, figs. 1 and 2.)

A daclis de ipon outfit may cost from 500 pesos to 650 pesos. The small boats (viray) cost from 250 pesos to 300 pesos each, and the ipon nets, 200 pesos to 350 pesos. One man may own one ipon outfit, or several persons may own a single ipon outfit.

During the ipon season the catch of a single ipon outfit is sold to ipon dealers, and after each month of the season the money is divided among the members of the crew, the shares of each person being dependent upon the amount of his stock. Persons who help in the hauling of the nets are given a cup of ipon after each haul.

The *tangar* is a large baglike net of coarse cotton cloth and sinamay. The bag is about 7 meters long, and the wings 6 meters long and 2 meters wide at their widest portion and 1 meter wide at the ends. Text fig. 1 shows the parts and accessories of the terminal portion of the wing of a tangar. To the cork line of the tangar are attached wooden floats 3 inches long and 2 inches in diameter, at intervals of 1 foot. To the ground rope of the tangar are strung earthen sinkers 2 inches apart. The extensions of the free end of both the cork line and the ground rope form the wing bridle. To these wing bridles the bamboo brails are attached. The pull ropes are joined to the bights of the wing bridle.

The tangar net is operated on a gradually shelving sandy shore near the river mouth facing the incoming high tide. The pull ropes are attached to 6 bamboo poles driven firmly into the sandy bed of the beach. The tangar is set from half an hour to one hour when there is an abundant run of ipon. The string of the end of the main bag of the tangar is untied, and what is caught is emptied into a separate accessory bag of sinamay. The tangar is a very effective apparatus used in the catching of ipon in Ilocos Norte Province.

The *tuad* (text fig. 2) is a seine made of either sinamay cloth or coarse cotton cloth, 15 meters long and 2.5 meters wide at its widest portion, tapering towards the end of each wing where it is about 1.5 meters wide. Strung to the cork line at intervals of 2 inches are numerous wooden floats, each 2 inches long and 1 inch in diameter. To the bottom line are strung at intervals of 1 inch several bone or earthen sinkers, each 2 inches long and 1 inch in diameter. Unlike the daclis de ipon (chinchorro), the tuad has no bag. It can be operated from bamboo rafts by 10 to 15 persons along shallow beaches and along the banks at the mouth of rivers. The tuad is used extensively in Amburayan River, or in Bangar at Baroro River of Bacnotan, and in Bauang-Naguilian River.

The bobo, which is bottle-shaped and which may be of different sizes, is made of fine bamboo splints. The ordinary ipon bobo

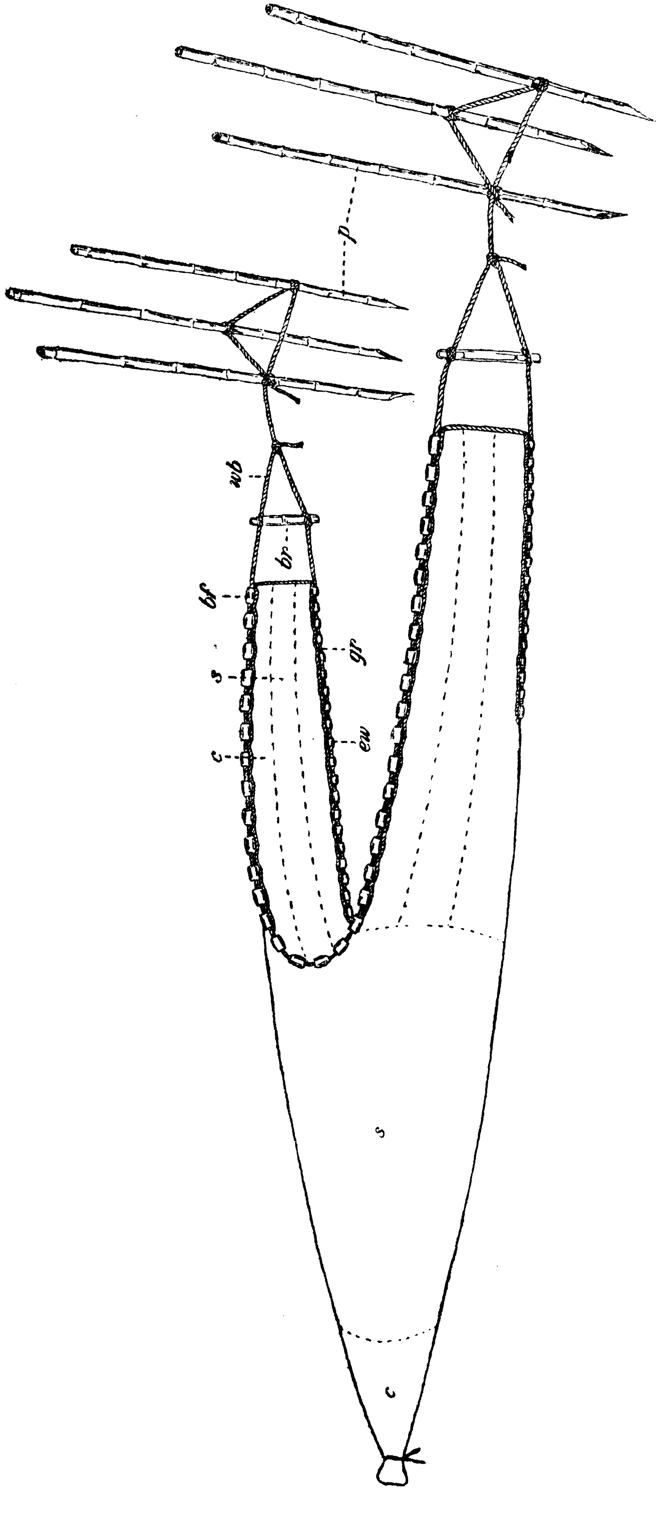

FIG. 1. **Tangar, a small chinchorro net; perspective view.** *c*, **Cotton cloth of bobo and wings;** *s*, **sinamay part of wings and end bobo;** *bf*, **bamboo float;** *wb*, **wing bridle;** *ew*, **earthen weight;** *gr*, **ground rope;** *br*, **brail;** *p*, **bamboo pilings where pull ropes are attached.** Ilocos Norte Province.

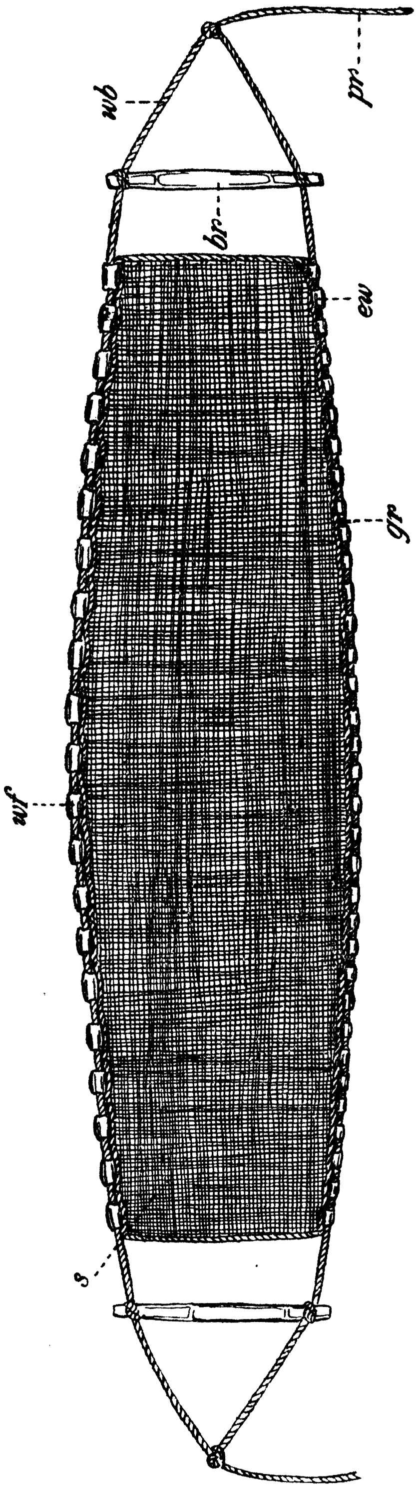

FIG. 2. Tuad net, diagrammatic. *wf*, Wooden float; *s*, sinamay; *br*, brail; *wb*, wing bridle; *ew*, earthen weight; *gr*, ground rope; *pr*, pull rope. La Union Province.

is about 80 centimeters long, the diameter of its mouth being 25 centimeters, and its posterior opening about 6 centimeters in diameter. The mouth of the bobo with a 4-hoop opening 25 centimeters wide is provided with a primary funnel about 20 centimeters long. Behind this primary funnel is a secondary inner funnel, 25 centimeters long, with a tube that has an opening 3 centimeters in diameter. The end tube of the inside funnel is in the same direction as that of the end neck of the bobo. When the bobo is used in the barricade traps the end neck is provided with a cloth stopper.

The pamoboan (*Plate 2, figs. 2 and 3, text fig. 3*).—In Laoag River, Ilocos Norte Province, the barricade ipon trap is known as pamoboan. The pamoboan is built in shallow water, from 2 to 4 feet deep. In text fig. 3, f and f_1 represent the primary head runners or parallel fences of the escapement, *padaoan;* these runners are from 5 to 12 meters apart, depending upon the width of the river. The walls which are attached to several bamboo pilings are regularly and firmly set in the river bottom. The runners, which are 2 meters high, are from 8 to

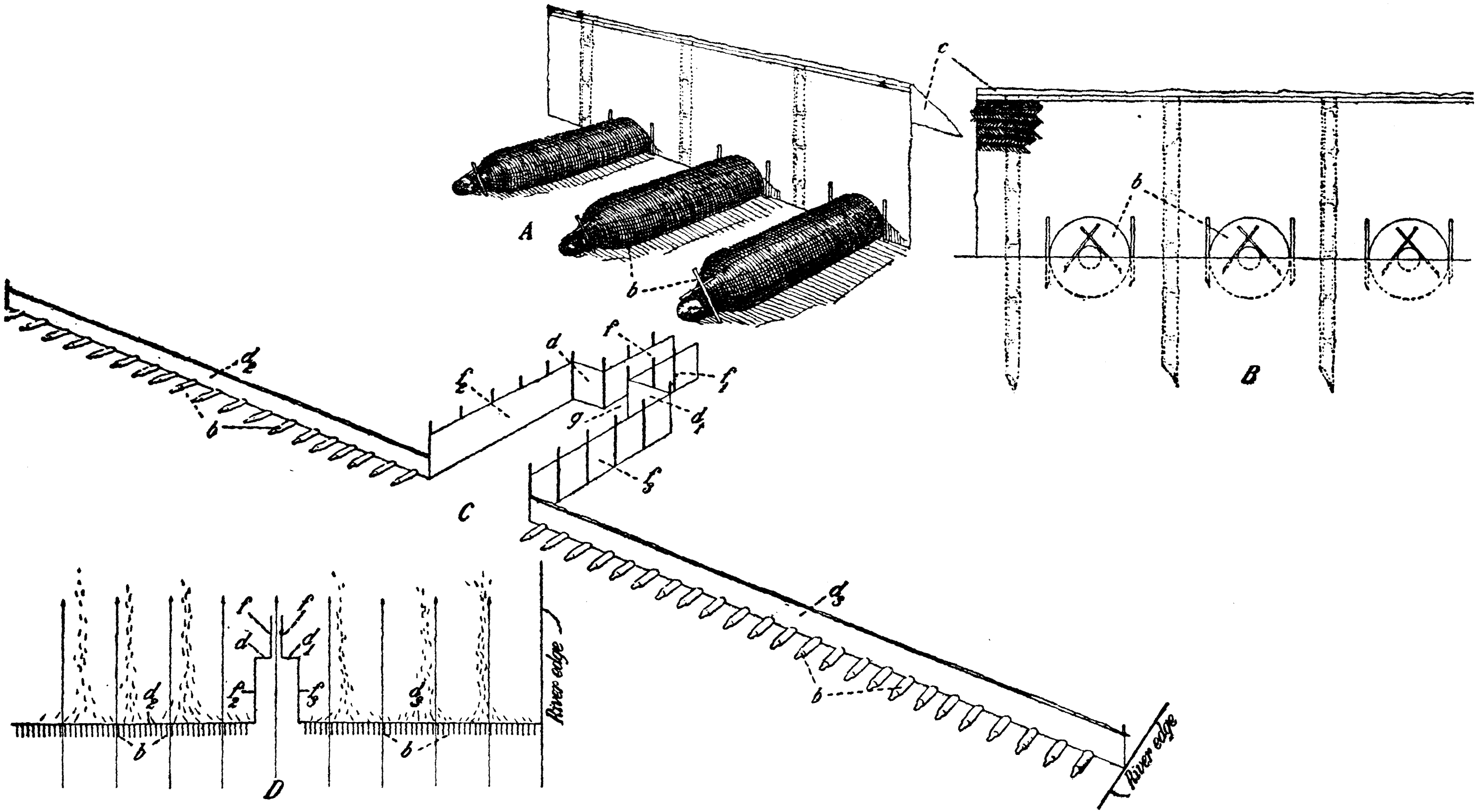

FIG. 3. Pamoboan or pingi. *A*, Perspective view showing main parts; *B*, a section of a perspective view of a pamoboan showing how bobos are set in the river bed and attached to d_2 or d_3, secondary barricade; *C*, *D*, plan views of pamoboan showing the accessory parts, direction of river current, and direction of ipon migration against current. Laoag River. *b*, Bobo; *f*, f_1, primary runners of sawali; f_2, f_3, secondary runners of sawali; *d*, d_1, primary barricade of sawali; d_2, d_3, secondary barricade of sawali; *g*, gate of escapement (padaoan).

10 meters long. The primary barricade of sawali is represented by d and d_1. It also is 2 meters high and is attached to several bamboo pilings on the upper ends of the parallel runners, f and f_1. These primary barricades are about 3 to 5 meters long. The secondary runners or parallel fences, which are attached to the left and right extreme ends of the barricades d and d_1, are represented by f_2 and f_3; these secondary runners are also 2 meters high and from 6 to 8 meters long. d and d_1 form the upper gate of the escapement, *padaoan*. d_2 and d_3 represent the secondary barricade of sawali, about 1 meter high and attached to bamboo pilings 2 feet apart. These secondary barricades of sawali and the row of bobos are placed below the sawali walls on the shallower portion of the river, extending to the left and right margins of the river. The bobos, which are placed a foot apart on a hollow river bed, are made to face downstream (text fig. 3, *C*). d_2 and d_3 are provided with strips of cotton cloth about 1 foot wide floating on the surface of the water above this sawali. The abrupt flow of the water above this strip of cloth is downward, creating a swift current. This cloth also protects the migration farther upstream. Unlike the swift current of the water towards the secondary barricades, the current at the escapement, *padaoan,* is not very swift, a condition that is unfavorable for the migration of the ipon. Every year there are from 10 to 18 pamoboans in operation in Laoag River. A pamoboan has 50 to 350 bobos.

The *pataya* (text fig. 4) is a simpler method of catching ipon in September, October, and November, when Laoag River is subject to floods. This device consists of the main barricade of cotton cloth set across either half or the entire width of a river. Behind the main barricade are several submerged runners, or fences of banana sheath.

The main barricade of cloth is attached to several bamboo stakes, 1 to 3 feet high, driven firmly in the river bed at intervals of 1 foot. A floating strip of cloth on top of the entire length of the barricade produces an abrupt flow of the water. The submerged low runners or fences of banana sheath which are about 1 foot away from the main barricade produce a swift current. Bobos are placed in between the runners facing the river current. A school of ipon migrating upstream retreat upon reaching the barricade cloth due to the abrupt flow of the water. The schools of ipon are then led between the runners

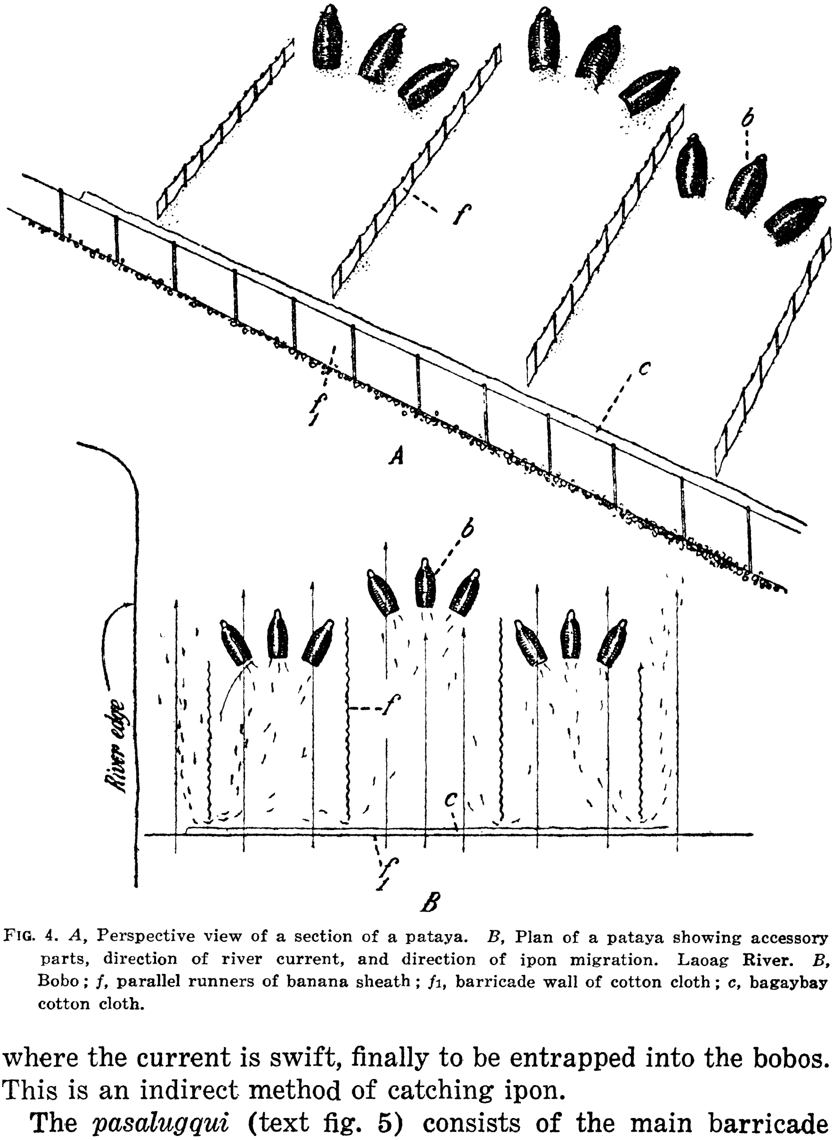

FIG. 4. *A*, Perspective view of a section of a pataya. *B*, Plan of a pataya showing accessory parts, direction of river current, and direction of ipon migration. Laoag River. *B*, Bobo; *f*, parallel runners of banana sheath; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth.

where the current is swift, finally to be entrapped into the bobos. This is an indirect method of catching ipon.

The *pasalugqui* (text fig. 5) consists of the main barricade of cloth and several low V-shaped submerged runners of banana sheath with the bobos set at the junction of the runners, facing the current of the river. This method is employed during the rainy season. The advantage of the barricade wall of cloth during the rainy months is that it sieves the mud carried away by the water, making the water clearer below the barricade and in between the runners where the water current is usually

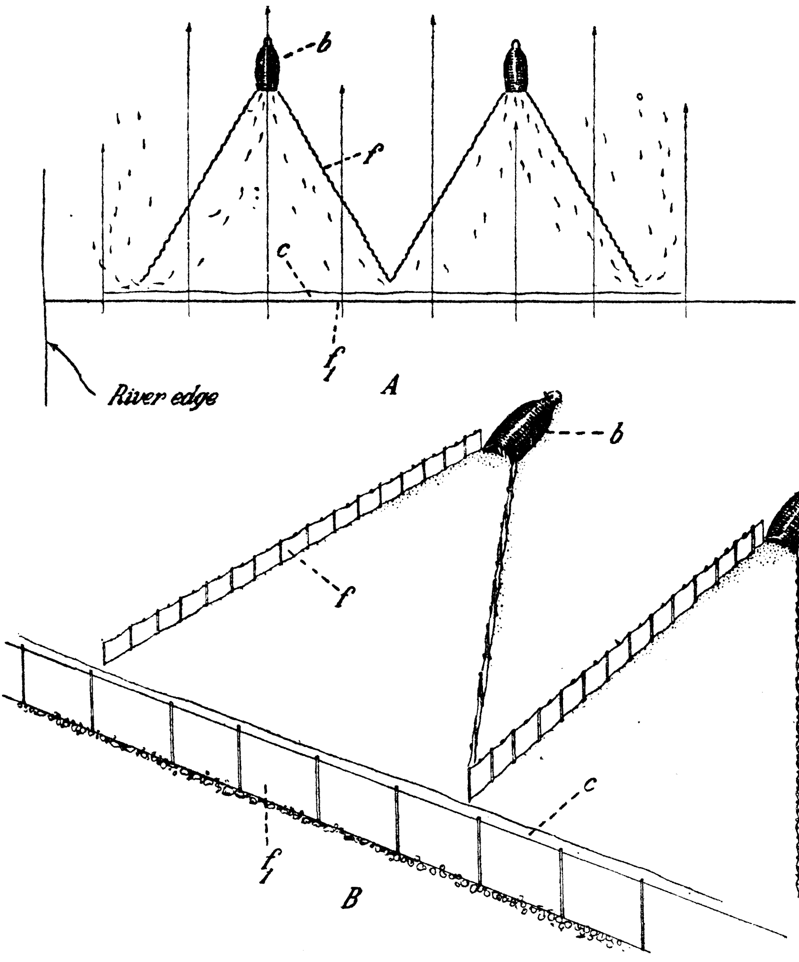

FIG. 5. *A*, Diagrammatic plan of a section of a pasalugqui; direction of river current and direction of ipon migration. *B*, Perspective view of a section of a pasalugqui showing parts. *b*, Bobo; *f*, banana sheath runners; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth. Laoag River.

swifter. The ipon are more active in clear water than in turbid water.

The lel-len (*text fig. 6*).—Along the margins of Laoag River, among the fresh-water algæ and the habitat of river snails, a very simple means of catching schools of ipon fry, called *tartarac,* is the lel-len. This gear consists of two parallel dams of pebbles and stones about 20 meters long and about 1.5 meters wide. Downstream towards the lower ends of the dams a matting of bamboo *akilis,* 2 feet long and 1 foot wide, faces the

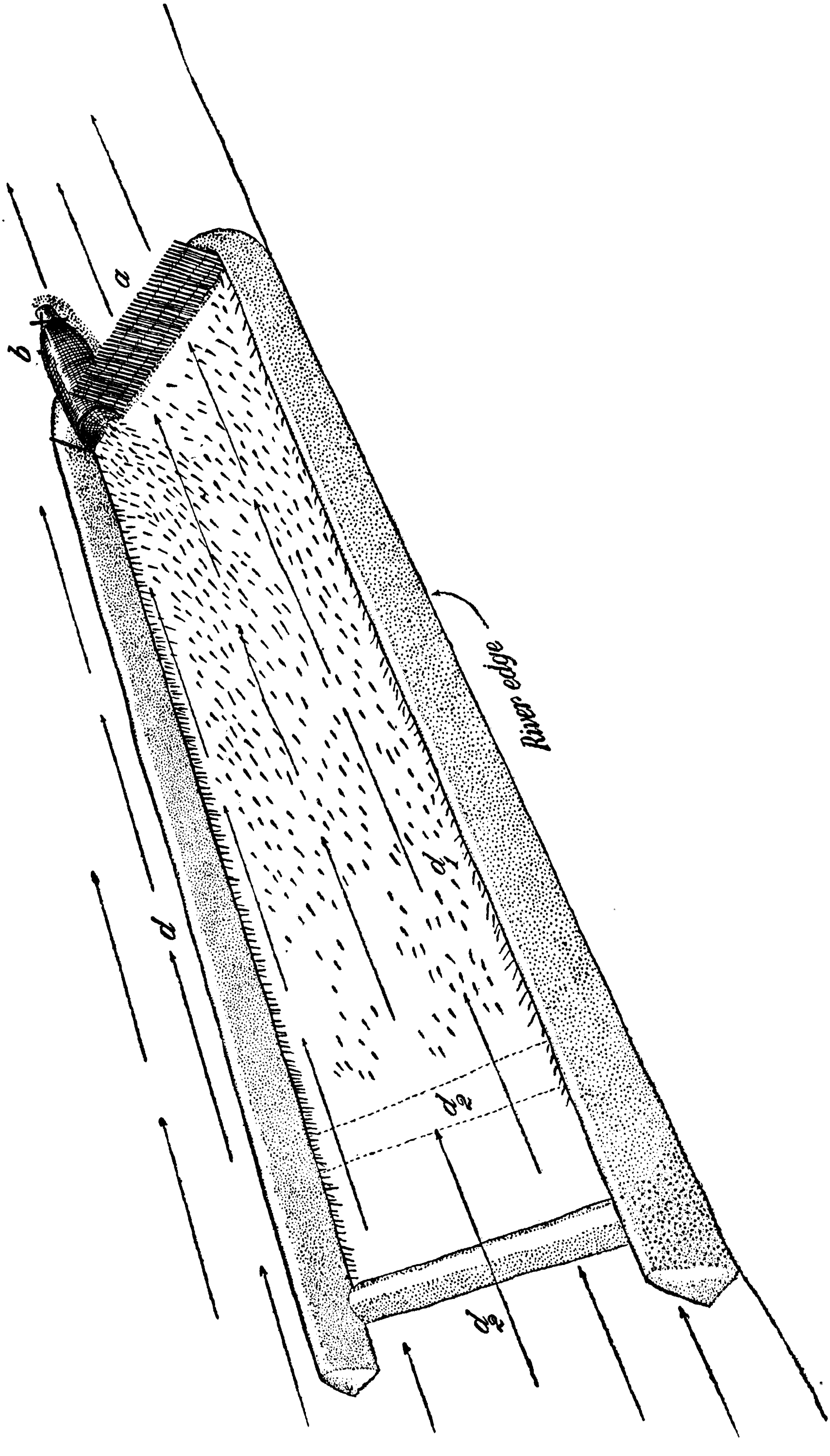

FIG. 6. Lel-len, diagrammatic. *a*, Bamboo screen (akilis); *b*, bobo; *d*, d_1, dams of sand; d_2, provisional dams of sand; direction of river current and migration of ipon, Laoag River.

flow of the water. In addition to the main dams there is a provisional dam that is moved gradually downwards toward the bobo and akilis, driving the enclosed tartarac into the bobo. The lel-len is a very simple device used in catching ipon along the margins of rivers.

The *paed* (text fig. 7) is a device consisting of several inverted V-shaped bamboo stakes, barricaded with galvanized iron walls and sinamay hoop nets laid across the entire width of a swift, shallow gravelly stream or river. In text fig. 7, f represents the head fence of a single paed, which is a semicircular wall of galvanized iron attached to several bamboo stakes, 1.5 feet long, piled on gravel bottom. f, the head fence, has a radius of about 10 inches. f_1 and f_4 are barricade fences of galvanized iron 2 meters long on each side and about 1 foot high. f_2 and f_3 represent galvanized-iron parallel fences, 15 inches apart, each fence about 1.66 meters long and about 1 foot high. g and g_1 represent the gates of the barricade at the left and right sides, each being about 8 inches wide. n and n_1 represent sinamay hoop nets attached to bamboo stakes at the gates and at the ends of the parallel fences towards the head fence. These nets are about 1 meter long, with a diameter of about 1 foot. In both outer sides of fences f_1 and f_4 are shallow canals leading to the gates at the mouth of the nets. The current of the water between the parallel fences f_2 and f_3 downwards from semicircular fence f is feeble and not very swift, the direction of the current being toward the gates. The presence of the submerged runners f_1 to f_4 and the canals on their outer sides produces the swift current of water towards the gate. The ipon that migrate upstream in the paed are able to swim above the fences f_1 and f_4 and then are led into the mouth of the sinamay hoop nets.

Herre (1927) described the paed as a less permanently deadly device. He described it as merely a cloth fence strung across the river with bamboo fish traps placed in openings at intervals of 4 or 5 meters. Herre's description does not agree with the illustration given in text fig. 7. The paed, which consists of a row of bobos set across the entire width of a river, is as effective as the pamoboan. The barricade walls of the paed are permanently set across the entire width of the stream during the ipon season. Whenever ipon migrate upstream, these hoop nets are attached to the bamboo stakes of the gates of the paed.

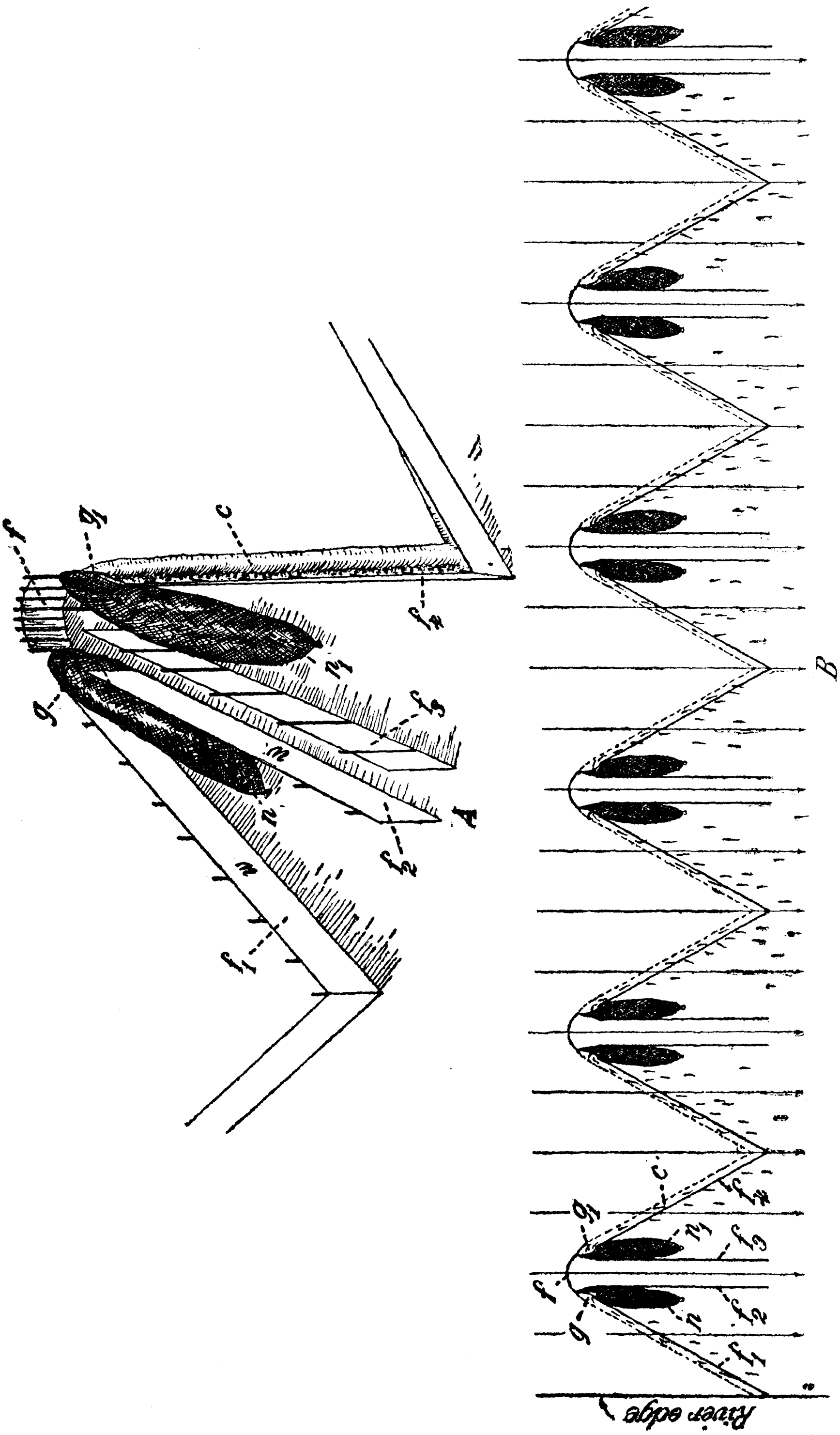

FIG. 7. *A*, Paed, perspective view. *B*, Diagrammatic sketch of a series of paed showing arrangement of runners, canals, hoop nets of sinamay, direction of river current, and migration of ipon. Bauang-Naguilian River. *c*, Canal leading into gate; *g*, g_1, gates; *n*, n_1, hoop nets of sinamay; *f*, semicircular barricade; f_1 to f_4, fences or runners; *w*, walls of runner, sawali or galvanized iron.

The *paayas* (text fig. 8) consists of a series of dams of pebbles and stones, 1 foot high, 1 foot wide, 15 meters long, and about 1 meter apart, built on the gravelly margin of a swift-flowing stream or river. At a distance of 10 meters from the head dams inverted V-shaped barricades of bamboo stakes with banana sheath walls are laid between the channels. At the opening intersection of each barricade a bobo with the mouth facing downstream is placed at each of the smaller openings of the diverging walls of the inverted V-shaped barricade. As the ipon migrate upstream along the margin of the stream, they find their way to the swift current of water between the parallel dams into the bobo.

The *caput* or dip net is a very handy device for catching ipon along the seashore and at the mouth of the river. One type of caput is a dip net of sinamay (text fig. 8) mounted on a triangular bamboo frame. Its mouth is about 1 meter on the sides, 1.5 meters at the base, and 0.5 meter on top. A fisherman operates the dip net by pushing it along the shallow beach and lifting it after the tide has receded.

Another type of *caput* (text fig. 9) consists of a conical sinamay bag about 1 meter long, its mouth having a diameter of 10 inches. It is attached to two small wooden or bamboo handles about 1 foot long.

The importance of the ipon fisheries.—The ipon fisheries of northern Luzon are undoubtedly among the most important fishing industries in the Philippines. A conservative estimate of their annual value is about 500,000 pesos. The time of fishing is about 15 days of each month from September to February of every year. A great number of people of the fishing villages are benefited by this seasonal industry.

Ipon is considered a delicacy by the people of northern Luzon. The catch is usually sold in the local markets fresh, salted, or as *bagoong.* Ipon can be prepared for food in several ways; such as pickle, *tamale,* and *sinigang.* Ipon pickle is prepared by adding ¼ cup vinegar to 1 cup of fresh ipon, seasoned with salt and pepper. Tamales are made by wrapping fresh ipon banana leaves and boiling them in water with about four tablespoonfuls of vinegar and a tablespoonful of salt. Sinigang is made by boiling one cup of fresh ipon in 1¼ cup water, with sliced green or ripe tomatoes. Ipon *bagoong* is prepared by adding two parts of salt to five parts fresh ipon or two parts of ipon to one part salt. The containers used are earthen jars

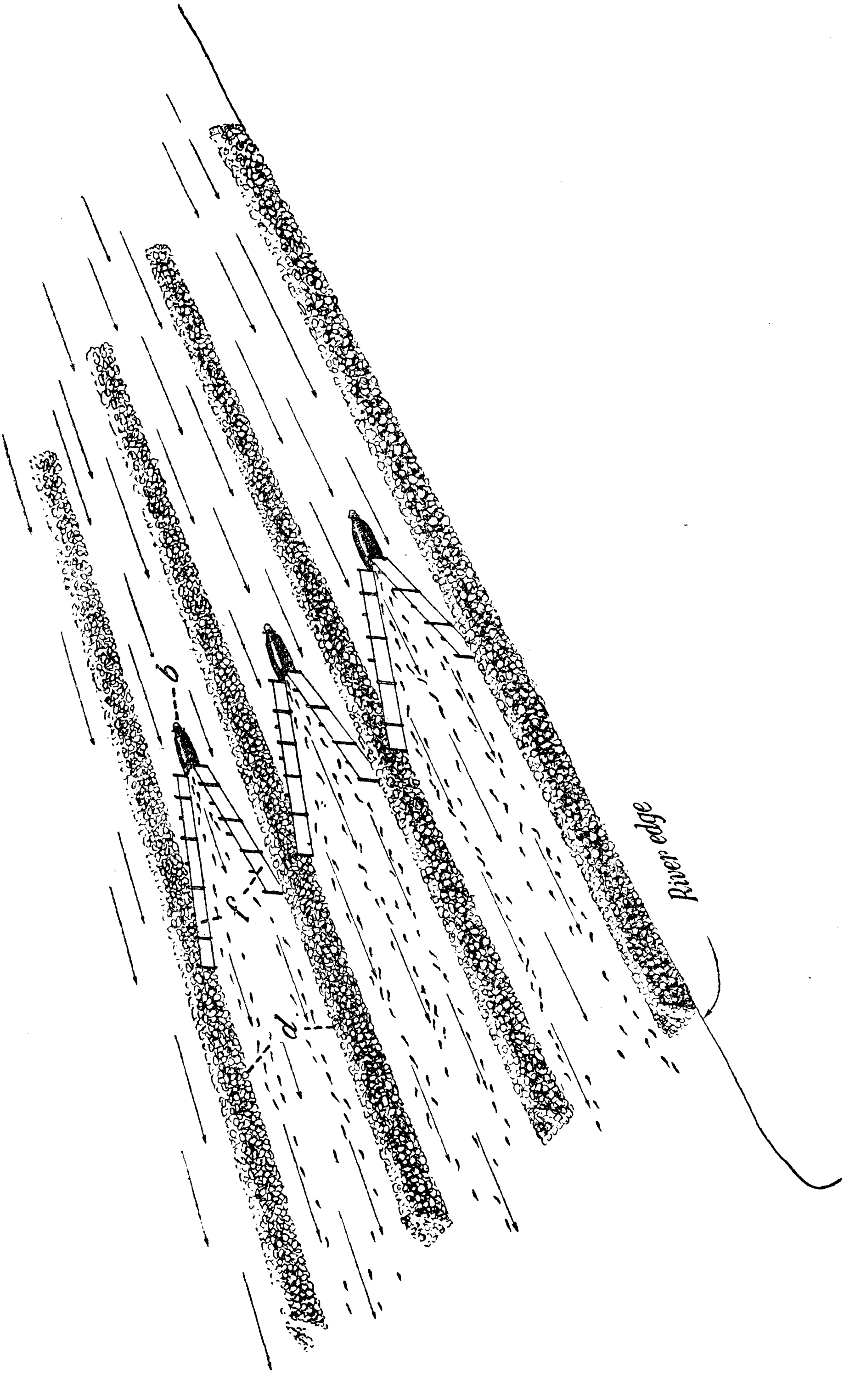

FIG. 8. Paayas, diagrammatic. *b*, Bobo; *f*, runners or fences of banana sheath; *d*, dams of stones. Bangar, La Union Province.

locally known as *burnay*. A burnay filled with salted ipon is then covered with a piece of clean cloth and then left to ferment for one to two months.

In Ilocos Norte Province, the ipon fisheries are commercially important along the shores of Gabu and La Paz, at the mouth of Laoag River, which is about 11 kilometers from the town. This river starts from several eastern streams, passing through the towns of Nueva Era, Banna, Solsona, and Piddig to form the main river flowing west through the towns of Dingras, Sarrat, and Laoag. In February, March, April, and May, the streams are shallow, narrow, and fairly rapid; but during the rainy season they are fed by the torrential rains from the Cordillera Mountains, and the main river becomes flooded. During floods the river is very swift, several meters deep, and less than a kilometer wide at its mouth.

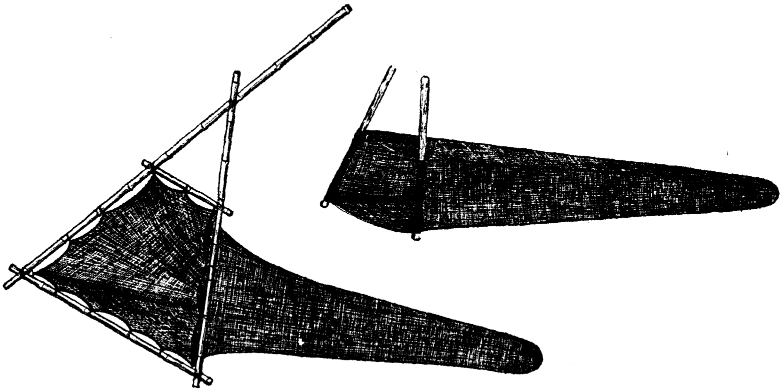

FIG. 9. Dip nets.

In November and December, 1934, and January, 1935, during the height of the ipon season the daily catches of ipon at La Paz Barrio, Laoag, and at Laoag River were recorded in order to determine the rate at which the fry were removed from the fishery by the various effective fishery devices. During the third run in November, 1,421 5-gallon cans of ipon, valued at 7,105 pesos, were caught in seven days; for the fourth run in December, 904 5-gallon cans of ipon, valued at 4,520 pesos, were caught in twelve days, and for the fifth run, 956 5-gallon cans of ipon, valued at 4,780 pesos, were caught in seven days.

During the third, fourth, and fifth "runs" of ipon at Gabu and La Paz Barrios, Laoag, a total of 4,370 5-gallon cans of ipon (82,702.25 liters) were caught. The total value of the

ipon caught during these three "runs" amounted to 21,845 pesos. For the six "runs" of ipon for 1934 and 1935, the estimated value of 7,000 5-gallon cans of ipon caught amounted to 35,000 pesos.

There were fifteen registered chinchorro nets for the municipality of Laoag, and the fees collected for the first and fourth quarters of 1934 and 1935 amounted to 174 pesos. There were 2,068 bobos in 18 ipon traps at Laoag River. The fee for all the bobos used at Laoag totalled 277.70 pesos (15 centavos for each bobo at a first-class location and 10 centavos each for a second-class location).

Other fishing regions for ipon in Ilocos Norte Province are at Bangui Bay, Bacarra River, and Gaang and Gabot shores.

In Ilocos Sur Province the known ipon fishing grounds are at Santa and Caoayan shores, Santa-Abra River, Santa Cruz River, and Amburayan River at Tagudin.

Ipon is caught along the seacoasts, and at Amburayan-Baroro, Bauang-Naguilian, and Aringay Rivers of La Union Province.

In Cagayan Province ipon fishing is done at Abulug and Cagayan Rivers, and at Aparri and Buguey shores.

Recommendations.—Remedial and regulatory measures for the ipon fisheries of northern Luzon are recommended to insure the stability of the stock and the source of supply.

Definitions.—For the purpose of the proposed Administrative Order, ipon shall mean the fry or fingerlings of gobies found in Cagayan, Ilocos Norte, Ilocos Sur, La Union, and Zambales Provinces; traps shall include bobo, sarep, pataya, pamoboan, pingi, padait, paculud, pasalugqui, paed, burayoc, lel-len, and etter, and similar fishing traps and fishing devices.

Restrictions.—(*a*) No bobo traps shall be constructed within 200 meters from the mouth of any river system, and the intervals between them shall be no less than 200 meters; (*b*) ipon traps shall be so constructed as to leave open the middle third of the width of a river or stream to allow ipon or other fishes free passage during their migration upstream or downstream.

Prohibitions.—It shall be unlawful for any person, association, or corporation to use (*a*) bobo or other similar devices in catching ipon from January to March 31 of each year; (*b*) no sarep, paculud, cascasad, sacsaclang, pasarsur, and kitang shall be used from April 1 to May 31 of each year; (*c*) ipon nets, like chinchorro, tangar, garamgam, and tuad shall be used only

along the shores below 100 meters on both sides of the mouth of a river from January 1 to March 31, and from September 1 to December 31 of each year.

The advantages of the restrictions on the use of bobo traps (paed, pingi, pasalugqui, paculud, paayas, pamoboan, pamalibotocan, burayoc, etter, and others) are (*a*) there will be a reduction in the number of bobos in the series of traps if the middle third of the width of the river is free; (*b*) there will be a greater proportion of escapement if the traps are 200 meters apart; (*c*) the people upstream will be benefited, because there will be less chance of the ipon being caught downstream; (*d*) escapement upstream will be enough to keep up the balance of stock that should reach sexual maturity.

The advantages of the prohibitions are (*a*) the prohibition of the use of the bobo in January, one month during the height of the ipon season up to February and March when the season is at its ebb, insures a greater stability of escapement to keep up the balance of stock; (*b*) protection of the maturing gobies that are still migrating in April and May; (*c*) avoidance of the obstructions to the trend of migration of the ipon along the shore 100 meters distance from each side of the mouths of rivers; (*d*) allowing the people upstream the benefit of catching a greater number of adult gobies in June, July, and August.

However, there are some objections of fishermen to the restrictions and prohibitions proposed. Fishermen who employ bobo traps claim that their catch in October, November, and December is very much reduced by the opening of the middle third of their series of traps and the greater distance between traps. On the other hand, these restrictions have been recommended primarily to put an end to controversies between people upstream and downstream by giving the residents upstream a chance to catch ipon; and secondarily, to set free a reasonable number of the fry to reach upstream in order to keep up the balance of stock.

Another serious objection of fishermen to the prohibition of the use of chinchorro net below 100 meters on both sides of the mouth of a river is that they are unable to catch ipon at the mouth of a river, where the catch is supposedly great. Others claim that some rivers have very rough shores where they are unable to use their boats and ipon nets. However, this prohibition is recommended to rehabilitate the river systems. If

the trend of migration of the ipon is disturbed due to the use of several boats and nets at the mouths of rivers, the chance of the ipon to enter the river is reduced, and the ipon are either caught or carried away by the waves.

The effectiveness of the restrictions and prohibitions in increasing the stock can be determined by actual trial and careful observation of the result. Administrative Order No. 6, series 1924, should be amended to relieve the present economic difficulties in the upper towns of the river systems of the Iloko regions.

SIGANID-FRY FISHERY

The fry of the species of the genus *Amphacanthus*, of the family Amphacanthidæ, are known as *padas* and *yomoyobyob* (Ilk.), *padas* (Pang.), *kuing* (Bicol), and *kuyog* (Vis.). The adults of these fry are known as *barangan* and *malaga* (Ilk.), *batawayi* and *turus* (Bikol), *danguit, mandalada, layap,* and *tayog* (Vis.), *belony* and *indogan* (Tao, Sug., and Samal) and *samaral* (Tag.).

The members of the family Amphacanthidæ are small to moderate-sized fishes, reaching a maximum length of 40 centimeters. They are herbivorous fishes inhabiting submerged coral reefs. Some are brilliant or dull in color. As a group they are excellent sources of protein food. The fry when they appear in schools are generally 1 to 3 centimeters long.

Fishing grounds and seasonal occurrence.—The important regions where the siganid-fry fisheries are located are on the coral reefs of Puro, San Vicente, Gonzaga, Buguey, and Claveria Municipalities, Cagayan Province; Palanan Bay, Isabela Province; Bobon Barrio, and Buraan Sitio, Burgos Municipality; Davila Barrio, Pasuquin Municipality; Gaang, Currimao Municipality; Gabot, Badoc Municipality; Ilocos Norte Province: Pugos Barrio, Sinait Municipality; Pugus, Cabugao Municipality; Puro Pingit, Magsingal Municipality; Santa Maria, San Esteban, Santiago, and Narvacan Municipalities, Ilocos Sur Province: Lingayen Gulf, Pangasinan Province: western coast of Zambales Province: Camarines, Sorsogon, Bohol, Cebu, and Surigao Provinces, and the Sulu group.

The catching of siganid fry varies throughout the Philippines. For instance on the northern and northwestern coast of Luzon, siganid fry are caught from August to September and from March to May. In the Visayas, they are taken in great quan-

tities from Tagbilaran, Bohol, from May to June, since the spawning activity of the adult siganids is from January to February. (Manacop, 1936).

Methods of catching siganid fry.—Siganid fry are caught with fine-meshed chinchorro nets called *kamang* or *tangar* on the northern and northwestern coast of Luzon. In the Visayas siganid fry and eggs are caught in the pounds of the fish corrals.

Throughout the Philippines the practice of catching breeding siganids with baclad, tangar, gill nets, and spear guns, and siganid fry with baclads and fine-meshed chinchorros, is a factor of depletion of the siganid-fry fishery. Siganid fry may appear abundantly in one year and not at all in the next two years.

Importance of siganid-fry fishery.—There are no records of the annual catch of fry throughout the Philippines as a whole. The scarcity of adult siganids and the absence of padas in northwestern Luzon in 1935 and 1936 are an alarming indication of the depletion of the siganid-fry resources of that region.

Siganid fry caught are made into bagoong or *guinamos,* a delicacy much liked by the people of Luzon. Dañgit eggs that are gathered from the pounds of the fish corrals of Bantayan, Cebu, are also salted in the proportion of three to four gantas of salt to one 5-gallon can of dañgit eggs.

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ILLUSTRATIONS

PLATE 1

FIG. 1. A saplar for catching bañgos fry at the mouth of the Bobon-Buraan tidal creek, Burgos, Ilocos Norte Province.

2. Segregating the bañgos fry from other larval fishes and transferring the bañgos fry in the palayok.

3. Catching bañgos fry with sagap at the marine shores of Bobon-Buraan, Burgos, Ilocos Norte Province.

PLATE 2

FIG. 1. Setting the bobos in the pamoboan, Laoag River.

2. Removing bobos from the pamoboan, Laoag River.

3. Removing the catch of ipon from the bobos.

TEXT FIGURES

FIG. 1. Tangar, a small chinchorro net; perspective view. *c*, Cotton cloth of bobo and wings; *s*, sinamay part of wings and end bobo; *bf*, bamboo float; *wb*, wing bridle; *ew*, earthen weight; *gr*, ground rope; *br*, brail; *p*, bamboo pilings where pull ropes are attached. Ilocos Norte Province.

2. Tuad net, diagrammatic. *wf*, Wooden float; *s*, sinamay; *br*, brail; *wb*, wing bridle; *ew*, earthen weight; *gr*, ground rope; *pr*, pull rope. La Union Province.

3. Pamoboan or pingi. *A*, Perspective view showing main parts; *B*, a section of a perspective view of a pamoboan showing how bobos are set in the river bed and attached to d_2 or d_3, secondary barricade; *C*, *D*, plan views of pamoboan showing the accessory parts, direction of river current, and direction of ipon migration against current. Laoag River. *b*, Bobo; *f*, f_1, primary runners of sawali; f_2, f_3, secondary runners of sawali; *d*, d_1, primary barricade of sawali; d_2, d_3, secondary barricade of sawali; *g*, gate of escapement (padaoan).

4. *A*, Perspective view of a section of a pataya. *B*, Plan of a pataya showing accessory parts, direction of river current, and direction of ipon migration. Laoag River. *b*, Bobo; *f*, parallel runners of banana sheath; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth.

5. *A*, Diagrammatic plan of a section of a pasalugqui; direction of river current and direction of ipon migration. *B*, Perspective view of a section of a pasalugqui showing parts. *b*, Bobo; *f*, banana sheath runners; f_1, barricade wall of cotton cloth; *c*, bagaybay cotton cloth. Laoag River.

FIG. 6. Lel-len, diagrammatic. *a*, Bamboo screen (akilis); *b*, bobo; *d*, d_1, dams of sand; d_2, provisional dams of sand; direction of river current and migration of ipon. Laoag River.

7. *A*, Paed, perspective view. *B*, Diagrammatic sketch of a series of paed showing arrangement of runners, canals, hoop nets of sinamay, direction of river current, and migration of ipon. Bauang-Naguilian River. *c*, Canal leading into gate; *g*, g_1, gates; *n*, n_1, hoop nets of sinamay; *f*, semicircular barricade; f_1 to f_4, fences or runners; *w*, walls of runner, sawali or galvanized iron.

8. Paayas, diagrammatic. *b*, Bobo; *f*, runners or fences of banana sheath; *d*, dams of stones. Bangar, La Union Province.

9. Dip nets.

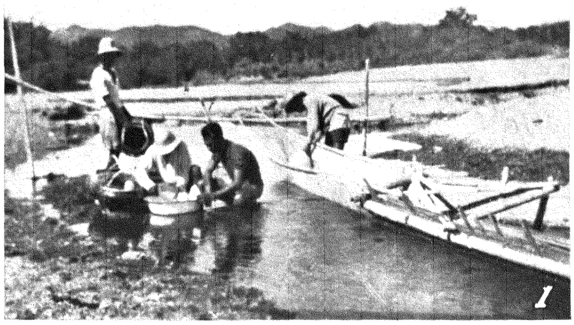

PLATE 1.

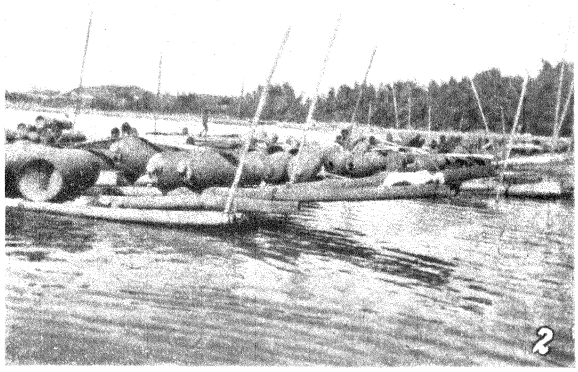

PLATE 2.

NOTES ON RECENT COLLECTIONS OF BIRDS FROM PALAWAN AND BUSUANGA

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ONE PLATE

The peculiarity of the fauna and flora of Palawan Island seems to have attracted many naturalists despite difficulties of transportation.

J. B. Steere,(16) of the University of Michigan, was the first bird collector to visit Palawan. He was in Puerto Princesa in July, 1874, and there collected specimens of 31 species, 10 of which were new to science.

Three years later, A. H. Everett, an English naturalist, spent December and parts of November and January in Puerto Princesa. According to Tweeddale,(17) Everett collected specimens of 52 species, 9 of which were new to science, and 32 had not been collected by Steere.

On the basis of his observations Everett(5) published comments on the zoögeographical relationship of Palawan.

Doctor and Mrs. Platen visited Puerto Princesa in the summer of 1887. According to Blasius,(3) who published the results of their collections, specimens of 130 species were obtained on this trip, 8 of which were new.

Sharpe(15) writes that E. Lempriere collected 31 species from Palawan.

In 1887 John Whitehead spent four months (probably July to October) at Taguso on the southeast coast, several kilometers south of Puerto Princesa. According to Sharpe,(15) Whitehead obtained 129 species, 8 of which are described as new. Whitehead(18) himself published his field notes of Palawan and enumerated all the species known from the island.

The members of the Steere Expedition were in "Paragua" (= Palawan) in August and September, 1887, according to Steere.(16)

F. S. Bourns and D. C. Worcester, who were members of the Steere Expedition to the Philippines in 1885–1888, returned to

Palawan in January, 1892, with the Menage Scientific Expedition. Accounts of their travels were published in Washington in 1898.(19)

R. C. McGregor collected in Palawan in December, 1901, and obtained a few bird specimens from Puerto Princesa(8) for the Bureau of Science. He again visited Malampaya Sound and Ulugan Bay in September, 1910. In 1925 McGregor again visited Puerto Princesa, making short trips to Iwahig Penal Colony and other nearby places. Accompanied by his three assistants in the Bureau of Science, McGregor stayed in Palawan Island from August to November, 1925. The birds obtained in 1925, however, were mostly sent to foreign institutions. Those retained in the Bureau of Science form a part of the basis of this paper.

A. Celestino and M. Canton, of the Bureau of Science, made collections in Puerto Princesa and Tinabog in December, 1905, and January and February, 1906. The results of that collection were published by McGregor.(9)

E. A. Mearns(11) added *Butorides spodiogaster*, which he shot near Malampaya Sound, to the list of Palawan birds.

As superintendent of the Iwahig Penal Colony from September 1, 1906, to February 4, 1908, John R. White collected several hundred specimens, which for some time were deposited in the Bureau of Science. McGregor made use of this collection temporarily in his care by taking notes for his Manual of Philippine birds.(10) The collection was later sold to the American Museum of Natural History in New York.

On the invitation of Colonel White, W. P. Lowe, an English naturalist, visited Palawan in June and July, 1907. With the help of Colonel White and the prisoners, Lowe(6) collected specimens belonging to 82 species.

John T. Zimmer, who was formerly in the employ of the Philippine government, collected birds in Palawan in March and April, 1906. He(20) enumerated 93 species, 60 of which were represented by specimens.

Between 1911 and 1927 W. Cameron Forbes collected birds in several parts of the Archipelago. He was occasionally assisted in his field activities by D. C. Worcester, R. C. McGregor, and A. Celestino. The birds, some of which were obtained from Palawan, were later turned over to the Museum of Comparative Zoölogy at Harvard University, and formed part of the basis of Bang's(1) publications.

I was informed that Mr. W. Parsons, of Manila, collects birds in Palawan from time to time, and that he sends his birds to London. Unfortunately I have not come across a publication describing his collection.

Mr. Graciano Castañeda, an officer in the Revenue Cutter "Arayat," collects birds whenever opportunity offers. He has collected a few specimens from Palawan and adjacent islands. Some of them are kept in the Collection of the Bureau of Science.

In April, 1936, F. Rivera and I spent 16 days in Bacuit and vicinity in northwestern Palawan, where we gathered data on the edible birds' nest industry. On this occasion collecting was done whenever convenient.

M. Celestino spent November, 1934, in Palawan and November and December, 1936, in Cuyo and Busuanga to enforce the fish and game law, and at this time was able to do a limited amount of collecting.

This paper is based on the birds collected by R. C. McGregor and party, by M. Celestino, and by F. Rivera and me; the specimens are now in the Collection of Birds of the Bureau of Science. The quoted field notes are from unpublished data of R. C. McGregor and were secured in Puerto Princesa; the others were taken by me.

GENERAL ECOLOGY OF NORTHWESTERN PALAWAN

In a previous paper(7) I partly indicated the general conditions of the rocks and caves in Bacuit and neighboring islands. Close to the rocky cliffs, swifts and swallows are plentiful, particularly during early morning and late afternoon. It should be noted, however, that the locality has varying ecological conditions. The topography is generally rugged. There are large areas of virgin forest, inspite of the fact that logging and clearing have been going on for many years. As a result of the activities of man, there are many second-growth forests and "kaiñgins" [1] adjoining virgin forests. On the dark debris-covered floor of the virgin forest may be noted occasional cleared circular areas, about 1 meter in diameter, which, according to the natives, are prepared by the male Palawan peacock pheasant during courtship (Plate 1). Scratches on the ground are the only indication of areas prepared by the Palawan peacock pheasant. Whitehead, according to Beebe,(2) considers these areas "showing off" arenas, but Beebe disagrees with Whitehead

[1] Cultivated areas on hillsides.

and seems to doubt the assertion that they were made by the peacock pheasant. Weird call notes of imperial pigeons, *Ducula ænea palawanensis,* may be heard from the tops of tall trees, where these birds cannot be seen on account of the thick foliage. In second growth and in kaiñgins the jungle fowl are seen and heard at any time of the day, but particularly at dawn and sundown. Many other species of birds occur in this type of environment. Coconut groves characterize most of the clear areas along the shore. Sunbirds, flowerpeckers, and doves may be seen in these places. In a number of tidal creeks and mangrove swamps along the shore, kingfishers, shore birds, and occasional sunbirds are characteristic bird life.

BIRDS RECENTLY COLLECTED FROM PALAWAN

MEGAPODIIDÆ

MEGAPODIUS NICOBARIENSIS CUMINGII Dillwyn. Palawan megapode.

One female, *Manuel and Rivera.*

The specimen was obtained while crossing a path in a thick brush. Natives of nearby islands informed me that on many islets in the Sulu Sea hundreds of megapodes come in April, May, June, and July to lay their eggs and leave for the mainland soon after the eggs have been laid. The inhabitants of the mainland, who are obviously familiar with the habits of this bird, then come in vintas,[2] and after a few days leave the islets with their vintas loaded with megapode eggs. This report is partly corroborated by G. Alcasid who with G. Maceda, both of the Bureau of Science, spent April and May, 1938, in Palawan. According to the former, they obtained a chick and four eggs from a mound in Stanley Island, in Green Island Bay, May 8. They found later that May 9 more than 30 eggs were obtained from the same mound by the moros. Their unfamiliarity with the habits of the bird and the nature of the mound were alleged to be the causes of their not getting all the eggs on May 8.

PHASIANIDÆ

GALLUS GALLUS GALLUS (Linn.). Red jungle fowl.

Two females, *McGregor;* 3 males and 2 females, *Manuel and Rivera.*

Crowing roosters were often heard on the hills during early morning. In the afternoon the birds were seen, generally in pairs, feeding in clear areas along the edge of second growth,

[2] Small native dugouts.

and on disturbance immediately seeking cover. The species appears common in many places in Palawan.

POLYPLECTRON EMPHANUM Temm. **Palawan peacock pheasant.**

Two males, *Manuel Celestino.*

In a foregoing paragraph was mentioned a cleared circular patch attributed to the Palawan peacock pheasant. The natives claim that this bird is very seldom seen by man in the forest, and that nearly all birds caught were snared. The specimens added to the Bureau of Science Collection of Birds in recent years were all trapped, and were kept in captivity for some time.

TURNICIDÆ

TURNIX SUSCITATOR FASCIATA (Temm.). **Philippine button quail.**

One male, *Manuel and Rivera.*

"Fully developed eggs were found in the ovary of the females." Comparing these with specimens from Luzon, McGregor observed the female birds from Luzon with the black of the fore breast heavier and the chestnut collar much wider. He says "If these characters and the slight difference in size are constant, they would justify the recognition of *T. haynaldi.*" Unfortunately not one of the birds he collected is available, and the lone male bird we secured does not show any difference from the Luzon bird.

COLUMBIDÆ

TRERON CURVIROSTRA ERIMACRA Oberholser. **Palawan thick-billed green pigeon.**

Nine males and 2 females, *McGregor;* 1 male, *Manuel and Rivera.*

In Puerto Princesa, McGregor notes, "abundant, in flocks—feeding in fruit trees. 200 to 300 feeding in a tall balete (*Ficus* sp.) in clearing near forest. When disturbed, bunches of 10–50 fly over. Almost impossible to see in the trees." In Bacuit small flocks of from 2 to about 20 birds were noted feeding in fruit trees, occasionally with one or two imperial pigeons, *Ducula ænea palawanensis.* They were also seen feeding on grape-like berries growing on a vine, *Columella* sp.

TRERON VERNANS VERNANS (Linn.). **Pink-necked green pigeon.**

Six males and 8 females, *Manuel and Rivera;* 1 male and 1 female, *Manuel Celestino.*

Like the thick-billed green pigeon, the pink-necked green pigeon was observed to form small flocks in the vicinity of Bacuit. These birds were generally seen on fruit trees of second-growth forest and on edges of cleared areas.

DUCULA AENEA PALAWANENSIS (Blasius). Palawan imperial pigeon.

Two males and 6 females, *McGregor;* 1 male, *Manuel Celestino;* 2 males, *Manuel and Rivera.*

Common, but not abundant in northwestern Palawan. Noticeable only by its weird note uttered from tall trees. McGregor notes, "not abundant—few seen at any time in tall trees in clearings. Parties of 4–8 flying over."

STREPTOPELIA BITORQUATA DUSSUMIERI (Temm.). Island turtle dove.

Two males and 1 female, *Manuel and Rivera.*

In the vicinity of Bacuit this bird was generally seen in pairs about clearings on hillside and in coconut groves. McGregor notes, "at times glides with wings outstretched and resembles a cuckoo or a small hawk."

STREPTOPELIA CHINENSIS PALAWANA Hachisuka. Palawan spotted dove.

Three males and 2 females, *Manuel and Rivera.*

The general habits are similar to those of *S. b. dussumieri,* although this bird is more often observed in coconut groves.

CHALCOPHAPS INDICA INDICA (Linn.). Emerald dove.

One female, *McGregor.*

In Puerto Princesa McGregor saw a nest of this bird with two eggs. In this connection he notes, "about 2.5 meters from the ground on horizontal limb of a small tree with a tangle of vines around. Nest directly over edge of water at high tide. Very close to town on bay side."

LARIDÆ

THALASSEUS BERGII CRISTATUS (Stephens). Large crested tern.

One male, *Manuel Celestino.*

GELOCHELIDON NILOTICA NILOTICA (Gmelin). Gull-billed tern.

One male, *McGregor.*

CHARADRIIDÆ

CHARADRIUS LESCHENAULTII Lesson. Large sand plover.

One male, *Manuel and Rivera.*

SCOLOPACIDÆ

ACTITIS HYPOLEUCOS (Linn.). Common sand piper.

Two males and 3 females, *Manuel and Rivera.*

These birds were feeding along the beach in Bacuit.

NUMENIUS PHÆOPUS VARIEGATUS (Scopoli). Eastern whimbrel.

Three females, *McGregor;* 1 female, *Manuel Celestino.*

ARDEIDÆ

BUTORIDES STRIATUS JAVANICUS (Horsfield). Javan green heron.

One male, *Manuel and Rivera.*

Rare in mangrove swamps.

DEMIGRETTA SACRA (Gmelin). Blue-reef heron.

One female, *McGregor.*

A female bird was taken by McGregor's party from Puerto Princesa October 16, 1925.

GORSACHIUS MELANOLOPHUS RUFOLINEATUS Hachisuka. Malay bittern.

One male, *McGregor.*

McGregor records, "Iris clear dull green yellow—skin in front of eye lumiere green, duller behind eye, greener on side of ramus (bill light green)."

FALCONIDÆ

ACCIPITER TRIVIRGATUS TRIVIRGATUS (Temm.). Crested goshawk.

Two males and 1 female, *McGregor.*

For some time the identity of this bird remained unconfirmed. McGregor notes, "doubtful, but perhaps this species." Comparing these specimens with others from other places justifies the identification.

STRIGIDÆ

STRIX SELOPUTO WIEPKENI Blasius. Palawan wood owl.

One male, *McGregor.*

NINOX SCUTULATA SCUTULATA (Raffles). Japanese hawk owl.

Two males, *McGregor.*

Of one specimen which he identified as *Ninox japonica,* B.Sc. 7958, McGregor notes

> Similar to two specimens from Japan although the upper parts are darker gray in the Palawan skin. Several owls from other parts of the Archipelago that I have called *Ninox japonica* seem to have much more white on the underparts and the upper parts more rusty brown than do other specimens. It seems probable that the Palawan skin represents *N. japonica* and that the Philippine specimen should be called something else.

Measurements.—Wing, 225 mm; tail, 121; culmen from nostril, 13; tarsus, 23.

NINOX SCUTULATA BORNEENSIS (Bonaparte). Bornean hawk owl.

One male, *McGregor.*

A small owl which McGregor labelled *Ninox scutulata.* In general appearance it resembles *N. s. scutulata* but is smaller. In the absence of material for comparison, the bird is tentatively

included in the Bornean race. This and the preceding race, *N. s. japonica,* are probably stragglers to this locality. According to Blasius (1888), a previous Palawan record of this race was made by Platen.

Measurements.—Wing, 225 mm; tail, 121; culmen from nostril, 13; tarsus, 23.

PSITTACIDÆ

PRIONITURUS DISCURUS PLATENÆ Blasius. Blue racket-tailed parrakeet.

Five males and 7 females, *McGregor;* 1 male, *Manuel and Rivera.*

Many birds congregate on tops of tall trees in cleared areas and on hills in the vicinity of Bacuit. They are noisy and very mobile. McGregor notes, "probably racket feathers of first year have narrow webs—new feathers on many specimens are already with bare shaft before far beyond the short feathers."

TANYGNATHUS LUCIONENSIS LUCIONENSIS (Linn.). Philippine green parrot.

One male, *Manuel and Rivera.*

Few birds were noted in Bacuit. A pair was seen coming out of a hole in the trunk of a tall tree on the hill.

CORACIIDÆ

EURYSTOMUS ORIENTALIS ORIENTALIS (Linn.). Broad-billed roller.

Two males, *Manuel and Rivera.*

Not very common in northwestern Palawan. Generally seen on cleared areas near the hills.

ALCEDINIDÆ

CEYX RUFIDORSUS Strickland. Red-backed three-toed kingfisher.

One female, *McGregor.*

McGregor notes, "In forest on low branch—sometimes edge of small pools in forest. Sits still and takes flight readily—when it flies away it utters a faint note."

RAMPHALCYON CAPENSIS GOULDI Sharpe. Palawan stork-billed kingfisher.

One male, *Manuel and Rivera.*

Two birds were noted by a river near Bancalen. Uttering its characteristic harsh notes the bird is seen on the wing moving swiftly from perch to perch.

ALCEDO ATTHIS BENGALENSIS Gmelin. Asiatic kingfisher.

One female, *Manuel and Rivera.*

Usually conspicuous over a stream watching for prey.

HALCYON CHLORIS COLLARIS (Scopoli). Philippine white-collared kingfisher.

One male, *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

Common in mangrove swamps, where it makes a lot of noise.

BUCEROTIDÆ

GYMNOLÆMUS LEMPRIERI (Sharpe). Palawan hornbill.

Six males and 2 females, *McGregor.*

Iris dark Brazil red bill chalky white distal lower part of crest overhung mahogany red base of lower mandible black skin around eye and throat pallid methyl blue, becoming dusky on chin—legs and feet and nails blackish brown, the legs slightly steel blue.

CAPRIMULGIDÆ

CAPRIMULGUS MACRURUS SALVADORI Sharpe. Palawan long-tailed nightjar.

Three males and 1 female, *McGregor;* 1 male, *Manuel and Rivera.*

The peculiar note of this nightjar, resembling the note produced by chopping wood in the forest, was often heard at night and at dawn. In Bacuit the bird is called *patul-tul,* from its note. McGregor notes:

First seen near our camp flying from mangrove over grassy area to forest. Could never find them in the mangrove though they seemed to come from there. Easily killed for they fly slow, fairly straight and high enough to be seen. As they fell in short grass, there was no danger of loss.

Occasionally, they flew too low to be seen until near at hand and thus almost impossible to shoot. One evening I was surprised to see one light on the grass within 10 meters of me and twice I saw one on top of a telephone pole.

Seen only for about a half hour at late dusk on moonless evenings. Not heard to call. Three to six usually went over within sight of one place.

MICROPODIDÆ

COLLOCALIA FUCIPHAGA AMELIS Oberholser. Whitehead's swiftlet.

One male and 1 female, *McGregor.*

McGregor observes:

Abundant near our camp, feeding over grass, clearings, rice fields and roads through forest. During rainy and windy weather it flew very low and could be easily shot. On two evenings it was abundant—a band of 50 or more feeding on flying termites as they come from the ground. They flew from 3 meters to just above the ground catching termites on the wing. The birds were so close that they sometimes collided with each other and two dashed into me.

COLLOCALIA FRANCICA GERMANI Oustalet. Gray-rumped swiftlet.

One male, *Manuel and Rivera.*

This swiftlet was seen going out and coming into the caves that are difficult of access. The tendency of its flight is upward from the cave opening and it is therefore hard to collect. In the cave the bird produces a squeaking note as if injured.

COLLOCALIA ESCULENTA MARGINATA Salvadori. White-bellied swiftlet.

Six males and 2 females, *Manuel and Rivera.*

Very common in Bacuit. Builds nest in caves not far from human habitations. Nest is made of moss with very little gelatinous substance. During early morning and in late afternoon hundreds of birds were seen feeding. They flew not far from the ground, and swooped on small winged insects.

CUCULIDÆ

SURNICULUS LUGUBRIS MINIMUS S. Baker. Glossy drongo cuckoo.

One male and 1 female, *McGregor.*

HIEROCOCCYX SPARVERIOIDES SPARVERIOIDES (Vigors). Large hawk cuckoo.

One male and 1 female, *McGregor.*

CACOMANTIS MERULINUS MERULINUS (Scopoli). Brain-fever bird.

Two females, *McGregor.*

They are smaller than the *C. merulinus merulinus* previously collected, but McGregor considered the size due to inmaturity.

Measurements.—Wing, 95 and 97 mm.

EUDYNAMYS SCOLOPACEA PARAGUENA Hachisuka. Palawan koel.

One male, *Manuel and Rivera.*

Not very common in the vicinity of Bacuit. Occasionally heard in second growth, very early in the morning.

CENTROPUS SINENSIS BUBUTUS Horsfield. Common coucal.

One male, *McGregor.*

McGregor notes, "seen once or twice at edge of forest—seems to be rare."

DRYOCOCCYX HARRINGTONI Sharpe. Harrington's cuckoo.

Three males and 8 females, *McGregor;* 4 males, *Manuel and Rivera.*

Our birds were shot in brush patches on the slope of a hill near Bacuit. McGregor notes, "bill emerald green, base of lower mandible blackish—skin in front of and around eye *nopal red,* legs and feet dull steel green—nails black. Seen in forest, often at considerable elevation in trees. Rather shy."

PICIDÆ

DINOPIUM JAVANENSE EVERETTI (Tweeddale). Palawan three-toed woodpecker.

Five males, *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

McGregor notes, "iris brown, tail blackish, lower mandible gray near base, legs and feet dirty courage green." I noted the birds on dead stubs on the hill.

CHRYSOCOLAPTES LUCIDUS ERYTHROCEPHALUS Sharpe. Red-faced golden flicker.

One male and 1 female, *McGregor;* 1 female, *Manuel and Rivera.*

The following were noted by McGregor, "iris carmine, bill bright chalcedony yellow; legs and feet dirty; bill green." Like the three-toed woodpecker, this flicker was noted on dead stubs out of town.

MÜLLERIPICUS PULVERULENTUS PULVERULENTUS (Temm.). Great slaty woodpecker.

One male and 1 female, *McGregor.*

THRIPONAX JAVENSIS HARGITTI Sharpe. Palawan black woodpecker.

Two males and 1 female, *McGregor.*

PITTIDÆ

PITTA SORDIDA SORDIDA (P. L. S. Müller). Black-headed pitta.

One male and 3 females, *Manuel and Rivera.*

Almost invariably heard calling on branches close to the ground.

MUSCICAPIDÆ

HEMICHELIDON GRISEISTICTA GRISEISTICTA Swinhoe. Common gray-spotted flycatcher.

One male and 1 female, *McGregor;* 3 males, *Manuel and Rivera.*

The bird was always observed perched singly on a branch of a tall tree.

CYORNIS LEMPRIERI Sharpe. Palawan blue flycatcher.

Three males and 3 females, *McGregor;* 3 females, *Manuel and Rivera.*

Obtained both on the branch of a tree with scanty leaves in a newly cleared area, and in the thickets close to the ground.

CYORNIS PLATENÆ (Blasius). Platen's flycatcher.

Two males and 1 female, *McGregor.*

McGregor notes, "bill black, legs, feet and nails gull gray."

HYPOTHYMIS AZUREA AZUREA Boddaert. Black-naped flycatcher.

Three males, *McGregor;* 1 male and 2 females, *Manuel and Rivera.*

This cheerful bird obviously prefers the underbrush.

RHIPIDURA JAVANICA NIGRITORQUIS Vigors. Black and white fantail.

One male, *McGregor.*

XEOCEPHUS CYANESCENS Sharpe. Large blue flycatcher.

Two males and 2 females, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

McGregor records, "in second growth thicket—seems to be very shy."

CULICICAPA HELIANTHEA PANAYENSIS (Sharpe). Philippine yellow flycatcher.

One female, *McGregor;* 1 male, *Manuel and Rivera.*

CAMPOPHAGIDÆ

CORACINA STRIATA DIFFICILIS (Hartert). Palawan cuckoo-shrike.

One male and 2 females, *Manuel and Rivera.*

PERICROCOTUS IGNEUS Blyth. Fiery minivet.

One male, *McGregor.*

PYCNONOTIDÆ

ÆGITHINA TIPHIA AEQUANIMIS Bangs. Palawan dwarf bulbul.

Five males and 1 female, *McGregor;* 1 male and 1 female, *Manuel Celestino;* 4 males and 5 females, *Manuel and Rivera.*

Gregarious to some extent. Common in shrubs in the vicinity of Bacuit.

CHLOROPSIS PALAWANENSIS (Sharpe). Palawan leafbird.

Nine males and 7 females, *McGregor;* 7 males and 5 females, *Manuel and Rivera;* 1 male and 1 female, *Manuel Celestino.*

Abundant in shrubs near Bacuit.

IRENA PUELLA TWEEDDALII Sharpe. Palawan fairy bluebird.

Nine males and 6 females, *McGregor;* 1 male, *Manuel and Rivera.*

McGregor notes, "Male and female strikingly different in colors."

BRACHYPODIUS ATRICEPS ATRICEPS (Temm.). Black-headed bulbul.

Fourteen males and 8 females, *McGregor;* 1 male, *Manuel Celestino;* 3 males and 1 female, *Manuel and Rivera.*

CRINIGER FLAVEOLUS FRATER Sharpe. Gray-throated hairy bulbul.

Four males and 2 females, *McGregor;* 1 female, *Manuel and Rivera.*

CRINIGER FINSCHII PALAWANENSIS Tweeddale. Palawan hairy bulbul.

Two males, *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

"Iris chalcedony yellow, bill chaetura drab above, lower mandible light neutral gray, legs and nails wood brown to buffy brown."

PYCNONOTUS PLUMOSUS CINEREIFRONS (Tweeddale). Ashy-fronted bulbul.

One male and 3 females, *McGregor;* 6 males and 3 females, *Manuel and Rivera.*

Habits and call note similar to those of *P. goiavier.* Commoner near town than in country. Scarcely seen in forest. Iris dark brown.

TIMALIIDÆ

MALACOCINCLA RUFIFRONS (Tweeddale). Rufous-headed babbler.

Three males, *McGregor.*

PTILOCICHLA FALCATA Sharpe. Palawan ground babbler.

One male, *McGregor.*

ANUROPSIS CINEREICEPS (Tweeddale). Ashy-headed wood babbler.

One male and 2 females, *McGregor.*

"Iris claret brown. On the ground in underbrush. Very quick and somewhat shy."

MIXORNIS FLAVICOLLIS WOODI Sharpe. Palawan tit babbler.

Two males and 2 females, *McGregor;* 1 male and 4 females, *Manuel and Rivera.*

"Iris isabella color—lower mandible light Payne's gray—upper mandible dark Payne's gray, almost black on culmen—legs, feet and nails light yellowish olive. Single bird usually in low growth."

TURDIDÆ

MONTICOLA SOLITARIA PHILIPPENSIS (P. L. S. Müller). Eastern rock thrush.

Two females, *Manuel and Rivera.*

Found singly on rock along shore.

SYLVIIDÆ

KITTACINCLA NIGRA (Sharpe). Palawan black shama.

Fifteen males and 4 females, *McGregor;* 5 males and 1 female, *Manuel and Rivera.*

"This species acts more like *Copsychus* than like *K. luzoniensis* and other Philippine shamas. The Palawan bird is seen in hedges and 2nd growth thickets near town and is not quick to take alarm."

ORTHOTOMUS RUFICEPS NUNTIUS Bangs. Palawan tailorbird.

Five males and 2 females, *McGregor;* 5 males and 3 females, *Manuel and Rivera.*

"Fairly common in thickets near settlement." Like other tailorbirds, it has several call notes.

PHYLLOSCOPUS BOREALIS BOREALIS (Blasius). Northern willow warbler.

Two males, *McGregor.*

ARTAMIDÆ

ARTAMUS LEUCORYNCHUS LEUCORYNCHUS (Linn.). White-bellied swallow shrike.

One male and 2 females, *Manuel and Rivera.*

Common near settlements and on hills, conspicuously perched on clear branches.

LANIIDÆ

LANIUS CRISTATUS LUCIONENSIS Linn. Philippine red-tailed shrike.

Two males, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

Rare in Bacuit during the latter part of April.

PACHYCEPHALA WHITEHEADI (Sharpe). Palawan thickhead.

One male and 1 female, *McGregor.*

PARIDÆ

PARUS AMABILIS Sharpe. Palawan tit.

Three males and 4 females, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

SITTIDÆ

CALLISITTA FRONTALIS PALAWANA (Hartert). Palawan nuthatch.

One female, *McGregor;* 2 males and 2 females, *Manuel and Rivera;* 1 male, *Manuel Celestino.*

"Bill scarlet, tip of upper mandible dusky—iris clear yellowish green, skin around eye yellowish oil green—legs dark liver brown—nails blackish brown."

DICÆIDÆ

DICÆUM SANGUINOLENTUM PYGMÆUM (Kittlitz). Pygmy flowerpecker.

Two males and 1 female, *McGregor.*

PRIONOCHILUS JOHANNÆ Sharpe. Palawan flowerpecker.

Twenty-five males and 12 females, *McGregor;* 2 males and 1 female, *Manuel and Rivera.*

PIPRISOMA AFFINIS (Zimmer). Palawan rusty flowerpecker.

Four males, *McGregor*.

The specimens were compared with those from Luzon, and a difference was noted particularly in the color of the upper parts. Zimmer(20) first described this bird as *Acmonorhynchus affinis*, which Riley(12) apparently overlooked when he described *Piprisoma diversum*.

NECTARINIIDÆ

CHALCOSTETHA CHALCOSTETHA (Jardine). Copper-breasted sunbird.

Four males and 1 female, *McGregor;* 1 male, *Manuel Celestino;* 7 males and 1 female, *Manuel and Rivera.*

"Abundant in mangroves—feet black, soles light orange yellow."

ÆTHOPYGA SHELLEYI Sharpe. Shelley's sunbird.

Two males, *McGregor;* 1 male, *Manuel Celestino;* 6 males, *Manuel and Rivera.*

Observed occasionally in thickets where a few pairs may be noted leaping from twig to twig.

LEPTOCOMA BRAZILIANA SPERATA (Linn.). Red-breasted sunbird.

Two males, *McGregor;* 1 male, *Manuel Celestino.*

LEPTOCOMA JUGULARIS AURORA (Tweeddale). Orange-breasted sunbird.

Fourteen males, *McGregor;* 1 male and 1 female, *Manuel Celestino.*

Common on coconut trees. A pair was observed in Bancalen building a nest inside a house situated in a coconut grove.

ANTHREPTES MALACCENSIS PARAGUAE Riley. Palawan brown-throated sunbird.

Twenty-one males and 7 females, *McGregor;* 1 male, *Manuel Celestino;* 2 males, *Manuel and Rivera.*

ARACHNOTHERA LONGIROSTRA DILUTIOR Sharpe. Pale spider hunter.

Four males and 1 female, *McGregor;* 3 males and 1 female, *Manuel Celestino.*

"Feeding on flowers of papaya. A. Celestino says it feeds on banana flowers."

MOTACILLIDÆ

MOTACILLA OCULARIS Swinhoe. Streak-eyed wagtail.

One female, *Manuel Celestino.*

MOTACILLA MELANOPE Pallas. Gray wagtail.

Two males, *McGregor;* 1 female, *Manuel and Rivera.*

MOTACILLA FLAVA SIMILLANA Hartert. Siberian yellow wagtail.

One male and 1 female, *McGregor.*

PLOCEIDÆ

UROLONCHA LEUCOGASTRA EVERETTI (Tweed.). Everett's weaver.

One male, *Manuel and Rivera.*

ORIOLIDÆ

ORIOLUS CHINENSIS CHINENSIS Linn. Philippine oriole.

Three males and 2 females, *Manuel and Rivera.*

Apparently not as abundant in Palawan as in Luzon.

ORIOLUS XANTHONOTUS PERSUASUS Bangs. Palawan black-headed oriole.

Four males and 3 females, *McGregor.*

"Very distinct from other Philippine forest orioles—much commoner and bolder."

DICRURIDÆ

DICRURUS HOTTENTOTTUS PALAWANENSIS Tweeddale. Palawan drongo.

Five males and 8 females, *McGregor;* 3 males and 3 females, *Manuel and Rivera;* 1 male, *Manuel Celestino.*

Fairly common in second growth.

DICRURUS LEUCOPHÆUS PALAWANENSIS (Whitehead). Palawan drongo.

One male and 1 female, *McGregor;* 2 males and 2 females, *Manuel Celestino;* 1 male and 2 females, *Manuel and Rivera.*

STURNIDÆ

STURNIA PHILIPPENSIS (Forster). Violet-backed starling.

One male and 1 female, *Manuel and Rivera.*

APLONIS PANAYENSIS PANAYENSIS (Scopoli). Philippine glossy starling.

Two males and 1 female, *McGregor;* 4 males and 2 females, *Manuel and Rivera.*

Small flocks were common on trees near cleared areas.

GRACULA JAVANA PALAWANENSIS (Sharpe). Palawan wattled myna.

Two males and 2 females, *McGregor;* 1 male and 1 female, *Manuel and Rivera.*

Feeding on fruits. Not very common. Generally in pairs, occasionally forming small flocks.

CORVIDÆ

CORVUS ENCA PUSILLUS Tweeddale. Little crow.

One male *McGregor;* 2 males and 2 females, *Manuel and Rivera.*

Common on hills, from where its caw-caw-like call may be heard at a distance below.

RESUMÉ OF THE KNOWN BIRDS OF PALAWAN

The above list includes 94 forms, recently collected from Palawan Island and now in the collection of birds of the Philippine Bureau of Science. This collection includes the 70 forms collected by R. C. McGregor and party in Puerto Princesa in 1925; 18 forms collected by Manuel Celestino in Taytay in 1934; and 59 forms collected by Francisco S. Rivera and me in Bacuit and vicinity in 1936. *Gelochelidon nilotica nilotica, Ninox scutulata scutulata, Collocalia francica germani, Collocalia esculenta marginata,* and *Piprisoma aeruginosum* represent additional records for this island. With *Pitta persola* Brodkorb and *Piprisoma affinis* (Zimmer) held valid, there will have been recorded from Palawan 197 forms.

BIRDS RECENTLY COLLECTED FROM BUSUANGA

Busuanga is the largest island in the Calamianes group. It is situated northeast of Palawan to which it is zoögeographically allied. In addition to what Worcester and Bourns(19) had mentioned about this island, Manuel Celestino, who collected the birds reported below, notes that Busuanga is topographically rugged. In the immediate vicinity of Coron, where M. Celestino did a little collecting at intervals while enforcing the fish and game laws, there are many cleared areas near hillsides. Towards the interior and not far from Coron are high mountains. Bamboo thickets are common on the hills and on the plain. Due to the very limited time devoted to actual collecting, only the 22 forms of birds listed below were obtained.

MACROPYGIA PHASIANELLA TENUIROSTRIS Bonaparte. Slender-billed cuckoo dove.

One male.

STREPTOPELIA CHINENSIS PALAWANA Hachisuka. Palawan spotted dove.

One male and 1 female.

NYCTICORAX NYCTICORAX NYCTICORAX (Linn.). Common night heron.

One male.

FALCO TINNUNCULUS DORRIESI (Swann). Kestrel.

One female.

STRIX SELOPUTO WIEPKENI (Blasius). Palawan wood owl.

One male and 1 female.

PRIONITURUS DISCURUS PLATENÆ (Blasius). Palawan racket-tailed parrakeet.

One male and 6 females.

TANYGNATHUS LUCIONENSIS LUCIONENSIS (Linn.). Philippine green parrot.

Two males and 3 females.

CEYX RUFIDORSUS Strickland. Red-backed three-toed kingfisher.

Three males.

GYMNOLÆMUS LEMPRIERI (Sharpe). Palawan hornbill.

One female.

DRYOCOCCYX HARRINGTONI Sharpe. Harrington's cuckoo.

One male.

DINOPIUM JAVANENSE EVERETTI (Tweeddale). Palawan golden-backed three-toed woodpecker.

Two males and 1 female.

HEMICHELIDON GRISEISTICTA GRISEISTICTA Swinhoe. Gray-spotted flycatcher.

One female.

CHLOROPSIS PALAWANENSIS (Sharpe). Palawan leafbird.

Two males and 3 females.

ORTHOTOMUS RUFICEPS NUNTIUS Bangs. Rufous-headed tailorbird.

One male.

PRIONOCHILUS JOHANNÆ Sharpe. Palawan flowerpecker.

One male and 1 female.

ÆTHOPYGA SHELLEYI Sharpe. Shelley's sunbird.

One male.

LEPTOCOMA JUGULARIS AURORA (Tweeddale). Orange-breasted sunbird.

Two males.

ANTHUS RICHARDI LUGUBRIS Walden. Indian pipit.

Two females.

ORIOLUS CHINENSIS CHINENSIS Linn. Philippine oriole.

Two females.

DICRURUS HOTTENTOTTUS CUYENSIS McGregor. Cuyo drongo.

Two males and 1 female.

DICRURUS LEUCOPHÆUS PALAWANENSIS (Whitehead). Palawan gray drongo.

Two females.

GRACULA JAVANA PALAWANENSIS (Sharpe). Palawan wattled myna.

One female.

RESUMÉ OF THE KNOWN BIRDS OF BUSUANGA

The above list contains 22 forms of birds obtained from Busuanga Island by Manuel Celestino. If the 80 forms recorded by Worcester and Bourns (19, p. 569) were all taken from this island, 4 forms are recorded for the first time from Busuanga. The new records for this locality are *Macropygia phasianella tenuirostris*, *Nycticorax nycticorax nycticorax*, *Falco tinnunculus dorriesi*, and *Strix seloputo wiepkeni*. These birds have been recorded both in Luzon and in Palawan, except *N. n. nycticorax* which has not been reported from Palawan. Further collecting in Busuanga will doubtless yield additional forms heretofore unrecorded.

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ILLUSTRATION

PLATE 1

A patch in deep forest supposedly cleared by the Palawan peacock pheasant.

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PLATE 1. A patch in deep forest supposedly cleared by the Palawan peacock pheasant.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

The Pharceutical Pocket Book. Published by Direction of the Council of the Pharmaceutical Society of Great Britain. London, The Pharmaceutical Press, 1938. 13th ed. 370 pp. Price, 5s.

This small volume consisting of 370 pages contains varied information that has surpassed the original intent of those responsible for the publication of the first edition which appeared in 1906 under the title of Pharmacy Students' Pocket Note-Book, 1906, because the volume is now rich in data that are useful not only to students of pharmacy but to practitioners as well.

The contents of previous editions were brought up to date and rearranged. The section on "Science and Art of Dispensing" which gives useful hints in compounding and dispensing medicines has been substantially rewritten and enlarged. A new section dealing with the new Poisons Law in Great Britain "gives a general outline of the principal provisions of the Pharmacy and Poisons Act, 1933, and the Poison Rules, 1935, as amended by the Poisons (Amendment) Rules, 1937, in so far as they affect the Pharmacists."—P. V.

Child Care and Training. By Marion L. Faegre and John E. Anderson. Minneapolis, The University of Minnesota Press, c1937. 4th ed. rev. 327 pp., illus. Price, $2.50.

There is a saying that theorizing about bringing up children is of no use, because by the time you begin to study the results of your theories, the children have grown up and new theories have sprung into existence. The trouble lies, of course, in the fact that you can have only one set of children on which you can set your ideas to work; for even if you live to see your children's children, you would not have a hand in bringing up the new generation. Not a welcome hand, because human nature being what it is, your grown children will have their own ideas about bringing up their own offspring.

What you need, apparently, is about five centuries in which to work out different experiments in order to find the best way of rearing babies, but at the end of five centuries, where are you?

Child Care and Training, by Faegre and Anderson, solves the problem. It incorporates for you what your five centuries can give you, all the best methods, past and present, for the care of children. All that is sane and sound—no fads and nonsensical novelties—about rearing children to health and happiness is put forth in understandable excellent style. The general reader may look into the book and gain some grains of truth, the parent may find guidance for his child—a problem child, or himself—a problem parent. And for parents-to-be, the book is a handy, practical reference to what lies before them.

Exceptionally well-organized, the chapters cover every phase of growing childhood, beginning with birth, and logically ending with the child as a grown unit of the family, having grown up physically, emotionally, mentally, and socially.

Written without brilliancy, but with clearness and ease, without too many technicalities but with a fine sense of childhood psychology, Child Care and Training is one of the really fine, useful books a person may own.—F. H. R.

The Treatment of Malaria; Study of Synthetic Drugs, as compared with Quinine, in the Therapeutics and Prophylaxis of Malaria. Fourth General Report of the Malaria Commission, and Appendices. Geneva. League of Nations Health Organization. 1937. 558 pp. Price, $0.65.

Based upon experiments conducted in Algeria, Italy, the Malay States, Roumania, and the Union of Soviet Socialist Republics, the Fourth Report, one would expect, ought to receive a warmer reception than what was accorded to its predecessor, "Therapeutics of Malaria," issued by the Commission in 1933. Involving a method exactly alike in all cases, but applied under different climates, species of insect vectors, strains of malaria parasites, human race, social grades, standards of living, and other factors, the experiments upon which the Fourth Report is based evidently attempted to eliminate the main objections raised against the 1933 report. It has been alleged, among others, that the Third Report arrived at ". . . too many general conclusions on the basis of results obtained in laboratory cases."

After a critical analysis of the results manifested by quinine, atebrin, plasmoquine, and various combinations of these drugs on trophozoites, gametocytes, acute clinical symptoms, frequency

of relapses, splenomegaly, and the general health of the patient, the Commission gives some practical suggestions for malaria treatment and prophylaxis. It believes that for ordinary infection of benign tertian, quinine is just as efficacious as atebrin, and that plasmoquine administered either with, or after, quinine or atebrin does not have any appreciable effect on the attack, although the frequency of subsequent relapses seems to be reduced. For malignant tertian infection, however, plasmoquine given together with quinine, or after atebrin, not only reduces relapses but has also a decided effect on the gametocytes. Collective treatment in the field with quinine or atebrin may, likewise, be advantageously accompanied or followed by plasmoquine so as to lessen relapses and reduce the number of gametocytes. Quinine, administered for collective treatment in daily doses of 1 to 1.30 g (for adults) for five to seven days or more, is similar in effect to atebrin given in daily doses of 0.30 g for five to seven days. For mass drug prophylaxis quinine in daily doses of 0.40 g, administered during the season of transmission, is claimed superior to a daily dose of 0.05 g of atebrin. Quinine, moreover, has the advantage of being cheaper, while its almost complete harmlessness allows it to be administered by subordinate personnel. Atebrin and plasmoquine, on the other hand, should be given under direct medical supervision. Their drawbacks, furthermore, are the production of yellow coloration on the skin by atebrin, and the toxicity of plasmoquine; if administered simultaneously the toxicity of each of these drugs appears to become aggravated.

The Commission still holds the opinion that up to the present no drug is yet known which can be safely and effectively used as a sporozoiticidal prophylaxis against malaria. Likewise, it believes that the eradication of malaria from a locality by curative and prophylactic treatment is impossible, since these methods cannot suppress the parasites in all carriers, although they may greatly diminish the morbidity.

—SECTION OF MALARIA CONTROL, BUREAU OF HEALTH.

Diseases and Surgery of the Dog; Alphabetically arranged. By Raymond J. Garbutt. New York, Orange Judd Publishing Company, Inc. 1938. 332 pp. Price, $3.50.

This book is a valuable treatise, embracing practically all the diseases and surgical conditions with which the canine family is afflicted. Written by one of the leading veterinarians of America who counts with a long experience and an extensive

practice in the large hospital of the American Society for the Prevention of Cruelty to Animals, this book will be highly informative to the veterinary practitioner, especially the discussion on the treatment and management of canine fractures. The chapter on canine feeding will be of special interest to the kennel breeder. The book is profusely illustrated, and where technical terms are used they are well explained in a language easily understood by the novice.

Like any other book in first edition, this book is not free from error. The latter, however, are not very grave, and, by and large, do not diminish the value of the text.

This book will be a valuable addition to the library of anyone interested in the study of kennels.—P. G. R.

The Construction of Vulcanite Applicators for Applying Radium to Lesions of the Buccal Cavity, Lips, Orbit and Antrum. By Desmond Greer Walker. Foreword by W. Warwick James. London, Published for the Middlesex Hospital Press by John Murray, 1938. 61 pp., illus. Price, 5s.

The author described with ample illustrations a new method of constructing a vulcanite applicator for applying radium to tumors found in the oral cavity, lips, orbit, and antrum. It is claimed that this applicator not only facilitates the proper distribution of radium irradiation during treatment, but also protects the neighboring tissues from the harmful secondary irradiation. In other words, this vulcanite applicator not only serves as an appliance to carry the radium needles to the desired location but also acts as a filter to the undesirable soft rays. Ingenious devices for the retention of the applicator during treatment, with maximum efficiency and comfort to the patient, are also included in the description. The vulcanite applicator can easily be constructed in a dental laboratory in collaboration with the physician dealing with radium therapy. This book is a very handy reference for dentists and radium therapists.

—V. G. V.

Punishment; its Origin, Purpose and Psychology. By Hans Von Hentig. London, William Hodge and Company, Ltd., 1937. 239 pp. Price, 12s 6d.

Few books have been written on the subject of punishment, and this one by the world-famous German criminologist, Hans von Hentig, is easily the most interesting. Originally written in German, it was translated into English for the English-speaking world.

In simple language and delightful style the author presents the origin, purpose, and psychology of punishment. With characteristic German thoroughness he discusses in five chapters the scope and limits, evolution, mental classification, means, and finally the development and future of punishment.

"Punishment," the author defines, "is organized hurt, an impairment of life organized in the form of laws, which society consciously uses to train humanity to avoid certain possible courses of action potentially injurious or hostile to itself."

Especially interesting is the chapter on the evolution of punishment, where the author takes us through the different forms and origins of punishment. The various means of punishment are also discussed, and of these probably the one that should attract the reader's attention most is the sterilization and castration of criminals. This means should be of especial interest to penologists and criminologists, in view of practices recently introduced in Germany and in some States in America, wherein castration and sterilization are mandatory for persistent offenders against morality.

Is castration abstractly a preventive measure or a punishment? The author answers with the rather cryptic remark, "The history of penal law shows that practically every organ which at one time or another was regarded as the seat of the soul or life force, the head, heart, blood and phallus, has also been the object of attack of penal law."

The readers can guess the author's stand on the problem of sterilization and castration, but if they cannot, they ought to read this most interesting book. Penologists, criminologists, psychologists, and sociologists—all students of crime and its prevention, should not fail to read von Hentig's work. The few hours spent going through the 239 pages will be well repaid.

—S. G. P.

Statistical Methods; Applied to Experiments in Agriculture and Biology. By George W. Snedecor. Ames, Iowa, Collegiate Press, Inc. 1938. 388 pp. Price, $3.75.

For those who have little or no knowledge of mathematics beyond arithmetic, this book gives the proper approach to the analysis and the interpretations of experimental results obtained in the fields of biology and agriculture. Without the use of elaborate mathematical analyses and formulas which characterize books on this subject, the interpretations and analyses of

experimental data in biology and agriculture are well presented. Even such subjects as poison and binomial distributions for large samples, and curvilinear regressions, all of which are mathematical in nature, are treated in a nonmathematical manner. The general method throughout the book has been made concrete by a wealth of applications and examples drawn mainly from the fields of agriculture and biology.

The development of the subject is logical, experiments involving one variate being fully treated first, giving due emphasis to computations of statistical parameters, such as the "measure of variability" (x^2, chi-square), and "test of significance." The mutual relationships of more than one variate in one or more groups are fully discussed, giving rise to such concepts as linear and nonlinear regressions, variance and covariance, correlation and partial correlation coefficients, and the like. These concepts are being introduced as they are needed in dealing with experimental data.

Mention may be made of the following special features of the book: The chapter on "short-cut" methods of computing statistical parameters, with reference to the use of adding machines, and the criteria in deciding how many significant digits are to be carried during the process of computations; second, the chapter entitled "Individual Degrees of Freedom," in which are introduced new ideas about comparison of means, and new methods of computing "test of significance;" for instance, devices for rapid calculation of mean squares from two means represented by two sums. Adequate references are given at the end of each chapter. Furthermore, because of the presentation and arrangement of the subject matter, the book is useful for a short course in statistical methods for biological and agricultural students.

The book as a whole is highly recommended as a practical aid to experimental workers, especially in the fields of biology and agriculture, who are in need of proper interpretation of the results of their experiments. Outside the fields for which it was written, this book is designed not for all students but only for those who are already acquainted with the subject of statistics and are only looking for statistical methods. The fact that examples and illustrations are drawn mostly from experiments in biology and agriculture makes the book useful only to those sciences.—T. J. J.

Mother Earth; Being Letters on Soil addressed to Professor R. G. Stapledon. By Gilbert Wooding Robinson. London. Thomas Murby & Co. 1937. 202 pp. Price, 5s 6d.

This book gives a clear description of the soil in its natural state and a discussion of different conditions and treatments of soil. The main object is to present the entire soil conditions and the different factors governing the improvement of the land for agriculture. Among the topics discussed in detail are humus, soil moisture, fertility, and soil amendments. The discussion under structure and tilth gives valuable data. Under soil surveys fundamental data for practical and scientific purposes are very concisely discussed.

The author emphasizes the need for proper soil management in order to maintain the crop-producing power of the land and to avoid the tremendous amounts of waste lands resulting from soil erosion. Land highly eroded cannot be reclaimed for agricultural purposes for a number of years. This point is strongly emphasized so that farmers should try their best to avoid the occurrence of soil erosion. There is a tendency among farmers to deplete and wear out the surface soil. High production always robs the soil of its fertility. The farmer should exert all efforts to continually replace what has been removed from the soil.

This book is written in the form of letters to all those who are in direct contact with Mother Earth upon whom our daily existence depends. It should be read by everybody regardless of vocation.—M. M. A.

Petroleum Technology. 1935. London. The Institution of Petroleum Technologists, 1936. 263 pp. Price, 7s 6d.

One in search of a book that would keep him abreast with the progress and developments of the whole science of naphthology will not only find in this book the very thing he desires, but will also be impressed that such a broad subject can be presented in so concise yet comprehensive a manner. This book consists of twenty-four articles, each presenting a review and descriptions of recent developments on the different phases or activities in petroleum technology. The book contains a total of 1,927 cited references. Included among the articles are those on geology and geophysics of petroleum; refining and cracking; lubricants and lubrication; asphalt and road materials; special

products, like cutting oils, sulphonated oils, special lubricants, insecticides, medicinal oils, and the like; analysis and testing of petroleum products; chemistry of petroleum; production technic; and statistics on world productions of petroleum.—I. P.

RECEIVED

CARPENTER, J. RICHARD. An ecological glossary. Norman, Oklahoma, University of Oklahoma Press, 1938. 306 pp., appendix. Price, $4.

FAEGRE, MARION L., and JOHN E. ANDERSON. Child care and training. 4th ed. rev. Minneapolis, The University of Minnesota Press, 1937. 327 pp., front., pictures. Price, $2.50.

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NEUROPTEROID INSECTS FROM THE PHILIPPINES

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ONE PLATE

Prof. L. B. Uichanco, of the University of the Philippines, sent me a number of neuropteroids for determination. Many were collected by various students, and a considerable number by Professor Uichanco and by Dr. C. S. Banks; a few were from the late Prof. C. F. Baker. I have added descriptions of a few new species from the Baker and Clagg material that had not been studied. Much of the material I received from Professor Baker had no dates of capture, so I have given the records with dates from Professor Uichanco's material, in which nearly everything was dated, at least to the month.

EMBIIDÆ

OLIGOTOMA SAUNDERSI Westwood.

NEGROS, Occidental Negros, La Carlota Central, March, 1930 (*L. B. Uichanco*).

OLIGOTOMA MASI Navas.

LUZON, Laguna Province, Los Baños, January 3, 1930 (*M. Plurad*), March 1, 1931 (*D. Tabije*), November 11, 1931 (*R. Base*).

PSOCIDÆ

PSOCUS BAKERI Banks.

LUZON, Laguna Province, Los Baños, January 21, 1935 (*G. A. Pangga*); Pili River, Mount Maquiling, altitude 80 meters,

February 19, 1924 (*D. Sulit*); Ilocos Norte, Paoay, December 28, 1931 (*F. Villanueva*).

PSOCUS OMISSUS sp. nov.

Similar to *P. lemniscatus*, apical marks similar, subbasal band wanting; only a black spot over basal part of radial sector, a black spot across anal cell near end; median cell only a little longer than broad, third median scarcely two and one-half times as long as broad, third median cell about as in *P. lemniscatus;* lower branch of radial sector separating from upper in a broad curve, which is here hyaline; lower end of median cell pale. Head, notum, and eyes as in *P. rizali;* hairs on male antennæ six to eight times the width of a joint.

MINDANAO, Mount Apo, Tia Ridge, altitude 6,000 feet, September (*Clagg*); Subulan River, October 11, altitude 2,000 feet (*Clagg*). Smaller specimens from Luzon (*Clagg*) and Samar (*Baker*). Two males lack the brown color in the third median cell. Type, M. C. Z. No. 22977.

PSOCUS RIZALI sp. nov.

In general similar to *P. lemniscatus* Enderlein, and formerly identified by me as that species. Differs from *lemniscatus* in having a nearly square median cell, in the much broader third median cell, and in a much more elongate second median cell. The subbasal band is broader than in *lemniscatus*, and there is a curved dark mark in the radial cell; both sexes marked the same. Head almost wholly pale, nasus bulging out in front; hairs of antennæ in female only a little longer than width of joint, in male fully four or five times as long; eyes of male not enlarged; notum shiny brown to nearly black, sutures scarcely marked with pale, subbasal band on hind margin reaching to base of wing (in *P. viscayana* broken long before base).

Lower branch of radial sector separating from upper in a broad curve, and here hyaline white; lower end of median cell also hyaline.

Length of forewing, female, 7 millimeters; male, 5.

Various specimens from Mount Maquiling, Luzon, and from Samar (21077), both collected by Baker. Type, M. C. Z. No. 22976.

PSOCUS ILLOTUS sp. nov.

Head dull gray, darker on clypeus and nasus; notum brown, sutures pale. Forewings with apical markings much as in *Psocus murudensis* Karny, but more extended. Stigma dark,

a spot behind angle of stigma extending across radial area and down on posterior side of areola postica to margin, two other spots in radial area, the one at tip pale in the middle, a spot at end of upper branch of radial sector, each of posterior cells margined along sides with dark, second cell with a band across a little below medius, also a spot at nodus and basal part of radial sector. Broad dark band over basal part of wing in *P. murudensis* wholly lacking in this species.

Wing rather slender, median cell much longer than broad, areola postica with a short top on medius (very long in *murudensis*), branches of radial sector separating in an acute angle. Hair on male antenna fully three to four times as long as width of a joint.

Length of forewing, 3.5 millimeters.

LUZON, Mountain Province, Benguet Subprovince, Baguio, July 10 (*McCoy*). Type, M. C. Z. No. 22978.

STENOPSOCUS JOCOSUS sp. nov.

Head pale, nasus and clypeus slightly brown in the middle, a black band from eye to eye through ocelli, antennæ (female) very pale, scarcely at all marked. Legs pale; notum with three large shiny black spots. Forewings with elongate stigma hyaline, an even broad black line along posterior margin of stigma, crossvein behind longer than width of stigma; lower side of median cell about twice as long as crossvein to medius, second branch of medius about parallel to posterior side of areola postica; separation of radial sector and medius hyaline for a short distance. Veins with few hairs, each about its length from next, hairs around outer margin few, very short, inconspicuous. Eyes (female) two diameters apart.

A male, which may belong here, has the eyes a little more than one diameter apart, the antennæ black, the stigma yellowish, and tips of femora and tibiæ dark.

Length of forewing, 4.2 millimeters.

From Basilan, and Zamboanga Province, Mindanao (*Baker*); male from Calian, Davao Province, Mindanao, July 11 (*Clagg*). Type, M. C. Z. No. 22979.

CÆCILIUS MUGGENBERGI Enderlein.

Nathanopsocus fuscolineatus C. S. Banks is a synonym; accession No. 18338.

AMPHIPSOCUS UNITUS Banks.

LUZON, Laguna Province, Los Baños, June 17; December 26, 1925 (*S. S. Gonzales*).

TAGALOPSOCUS HYALINUS Banks.

LUZON, Laguna Province, Mount Banahao (Kinabuhayan), May 21, 1933 (*V. J. Madrid*).

DYPSOCUS APICATUS Banks.

LUZON, Laguna Province, Los Baños, July 7, 1923 (*S. M. Cendaña*), June 2, 1918 (*C. S. Banks*).

HEMIPSOCUS ROSEUS Hagen.

LUZON, Laguna Province, Los Baños, June 15, 1932 (*S. R. Capco*).

LOPHOPTERYGELLA CAMELINA Enderlein.

LUZON, Laguna Province, Los Baños, September 27, 1915 (*C. S. Banks*); Laguna Province, Calauang, September 5, 1922 (*L. B. Uichanco*).

PERLIDÆ

NEOPERLA RECTA Banks.

LUZON, Laguna Province, Mount Maquiling, August 28, 1925 (*H. Protacio*); Los Baños, November 20, 1915 (*C. S. Banks*), February 15, 1931 (*Isabelo Monje*), October 12, 1929 (*F. Villanueva*), August 25, 1923 (*J. R. Bogayong*), November 19, 1930 (*E. Cada*), August 4, 1929 (*V. Villafranca*), June 23, 1925 (*U. Villar*).

NEOPERLA PALLICORNIS Banks.

LUZON, Laguna Province, Los Baños, January 3, 1932 (*M. Plurad*), February 3, 1925 (*F. Goseco*).

NEOPERLA VISCAYANA Banks.

LUZON, Laguna Province, Los Baños, March 1, 1931 (*D. Tabije*).

NEOPERLA OBLIQUA Banks.

LUZON, Laguna Province, Los Baños, October 29, 1916 (*F. B. Padolina*), January 11, 1917 (*T. Nisce*), January 8, 1917 (*C. R. Paulinan*) January 16, 1917 (*C. S. Banks*), June 1, 1914 (*E. Ejercito*), August 6, 1923 (*E. M. Sibal*), August 23, 1931 (*G. B. Viado*), March 1, 1931 (*D. Tabije*), July 21, 1927 (*P. Ungos*).

PHANOPERLA CLARISSA Banks.

LUZON, Laguna Province, Los Baños, January 26 and 29, 1915 (*C. S. Banks*), February 10, 1932 (*M. Plurad*), June 15, 1915 (*C. S. Banks*), August 8, 1923 (*P. V. Maclang*), September 18, 1929 (*S. M. Cendaña*), February 20, 1917 (*G. D. Cazeñas*), August 5, 1923 (*G. Guanzon*).

MINDANAO, Dansalan, altitude 300 feet, April 27, 1936 (*L. B. Uichanco*).

PHANOPERLA CONSIMILIS Banks.

LUZON, Laguna Province, Los Baños, June 1, 1915 (*C. S. Banks*), August 5, 1923 (*G. Guanzon*).

PHANOPERLA BAKERI Banks.

LUZON, Laguna Province, Los Baños, July 17, 1927 (*P. H. Viray*).

NOTHOCHRYSIDÆ (CHRYSOPIDÆ)

NOBILENUS BELLULUS Banks.

LUZON, Laguna Province, Los Baños, May 8, 1923 (*L. B. Uichanco*), July 10, 1923 (*F. S. Manipol*), December 26, 1930 (*M. Plurad*).

NOTHOCHRYSA EVANESCENS McLachlan.

LUZON, Laguna Province, Los Baños, July 11, 1930 (*C. Bagalso*), August 25, 1929, entom. student, September 9, 1915 (*C. S. Banks*), October 30, 1930 (*E. Lantin and V. Juan*); Mount Maquiling, altitude 285 meters, August 21, 1932 (*V. Asuncion*).

NOTHOCHRYSA ÆQUALIS Walker.

LUZON, Laguna Province, Los Baños, June 29, 1932 (*A. Y. Coronel*), July 9, 1922 (*S. Lantican*), July 9, 1927 (*H. T. Ramos*), October 15, 1928 (*E. A. Lanuza*).

ANKYLOPTERYX TRIPUNCTATA Girard.

LUZON, Laguna Province, Los Baños, August 19, 1926 (*Mrs. I. R. Cendaña*).

ANKYLOPTERYX BORNEENSIS Weele.

LUZON, Laguna Province, Los Baños, March, 1930 (*J. Abrenica*), December 23, 1930 (*E. Dumaguing*).

ANKYLOPTERYX NERVOSA Navas.

LUZON, Laguna Province, Los Baños, July 8.

CHRYSOPA ISOLATA Banks.

LUZON, Laguna Province, Los Baños, April 22, 1930 (*G. B. Viado*), August 15, 1915 (*H. Cuzner*).

CHRYSOPA MOROTA Banks.

LUZON, Laguna Province, Los Baños, May 21, 1923 (*S. M. Cendaña*).

CHRYSOPA MAKILINGI Banks.

LUZON, Laguna Province, Los Baños, April 21, 1930 (*V. J. Madrid*), Tolim, May 3.

CHRYSOPA ILOTA Banks.

LUZON, Laguna Province, Los Baños, July 7, 1921 (*M. Jaramila*).

CHRYSOPA TAGALICA Banks.

LUZON, Mount Banahao, crater, April 24, 1936 (*V. J. Madrid*).

CHRYSOPA NIGRIBASIS Banks.

LUZON, Laguna Province, Los Baños, March 15, 1915 (*C. S. Banks*).

CHRYSOPA (BORNIA) LUZONICA sp. nov.

Head pale yellowish, with a slight tint of reddish on vertex, no dark on cheeks; palpi pale, unmarked; antennæ pale; pronotum also pale, in one specimen with a faint median reddish streak, and more faint back on mesonotum; abdomen and legs pale.

Wings hyaline; venation pale, gradates brown, some radial crossveins and a few veins toward base of wing faintly brownish. In hind wings veins wholly pale.

Antennæ about two-thirds length of forewings; pronotum longer than broad behind, somewhat tapering forward. Wings rather slender, tips almost acute. In forewings radial sector but little curved; three series of gradates, eight in first, four or five in intermediate, eight in outer row; divisory veinlet ending just beyond crossvein; seven cubitals beyond it; twelve radial crossveins. In hind wing six inner and eight outer gradates, inner row rather nearer to radial sector than to outer row.

Length of forewing, 14.5 millimeters; width, 5.

LUZON, Laguna Province, Mount Banahao, in crater, April 22; altitude 974 meters, April 21 (*V. J. Madrid and G. T. Lim*).

Types in the College of Agriculture, University of the Philippines Collection, and M. C. Z. No. 23333.

OSMYLIDÆ

SPILOSMYLUS MODESTUS Gerstaecker.

LUZON, Laguna Province, Los Baños, June 15, 1932 (*A. Y. Coronel*).

MICROMIDÆ (HEMEROBIIDÆ)

ARCHÆOMICROMUS PUSILLUS Gerstaecker.

LUZON, Laguna Province, Los Baños, July 10, 1923 (*C. Crucillo*), September 15, January 5. MINDANAO, Lanao Province, Dapao Lake, Ganassi, altitude 3,000 feet, April 28, 1936 (*L. B. Uichanco*).

ARCHÆOMICROMUS IGOROTUS Banks.

LUZON, Laguna Province, February 17, 1923 (*G. B. Ingalla*).

MYRMELEONIDÆ

MYRMELEON CELEBESENSIS McLachan.

LUZON, Laguna Province, Los Baños, August 1, 1923 (*J. Barsana*), September 8, 1924 (*C. G. Manuel*), February 22, 1932 (*A. Palma*).

MYRMELEON ANGUSTIPENNIS Banks.

LUZON, Laguna Province, Los Baños, January 20, 1923 (*S. J. Aquino*), July 2, 1917 (*C. S. Banks*), July 4, 1923 (*L. Salazar*), November 1, 1931 (*M. Cera*), December 27, 1924 (*D. Suerte*).

HAGENOMYIA SAGAX Walker.

LUZON, Laguna Province, Los Baños, July 24 1918 (*C. S. Banks*).

DISTOLEON CLEONICE Banks.

LUZON, Laguna Province, Los Baños, August, 1926 (*C. Sundarasinha*), July 24, 1932 (*A. Barroquillo*), June 2.

NUGLERUS INSIGNIS sp. nov.

Head pale, a brown line below and one above antennæ; vertex with a transverse brown mark on each side, narrowly connected in the middle; palpi pale; antennæ pale, tips a little darker. Pronotum pale, on posterior part lateral margins broadly brown, on anterior part, sides and front margin faintly dark; long black hairs in front and some behind groove, shorter, curved; paler hairs on sides; mesonotum with brown spots, usually connected; metanotum more brown, tip of metascutellum shiny dark brown; on mesonotum very long erect black hairs, mostly in two groups on each side. Legs pale, base and tips of tibiæ darker, front coxæ long, with a broad, oblique, brown mark on outer side; spurs slender, curved near tips, equal to two joints; basal tarsal joint a little longer than apical joint, claws fully one-half of last joint; pleura with a brown stripe. Wings shaped as in other species (*scalaris* and *maculata*), tip of forewing hardly as acute as in *maculata;* a large bulla near tip of each pair.

Forewing with apical bulla brown, a smaller brown cloud over rhegma, and one on hind margin at end of anal vein. Between subcosta and radius thirteen brown spots (as usual), between each pair two or three brown spots from subcosta, not reaching across; in mediocubital area nine crossveins before and fourteen beyond stigma, these crossveins brown and more or

less bordered with brown; venation brown, in cubital area and anal area more pale; subcosta, radius, and cubitus interrupted with pale; hairs on veins moderately long. On hind wing apical bulla dark brown, a faint mark over rhegma; venation mostly brownish, paler in middle of apical half behind. Venation much as in other species; costals toward stigma forked; eight radial sectors; four crossveins before radial sector in forewing, two in hind wing.

Length of forewing, 28 milimeters; hind wing, 30.

LUZON, Laguna Province, Mount Maquiling (*C. F. Baker*). Type M. C. Z. No. 23020.

Readily separated from *scalaris* by more numerous marked veins in mediocubital area; from *maculata* (*Bofia*) separated by lack of middle dark spot near tip, by pale front (black in *maculata*), by single stripe on pleura (two parallel lines in *maculata*); femora pale above (with dark line in *maculata*).

The genus is peculiar in that there is no branch of the cubitus in the hind wing that can be identified as the cubital fork, the anal vein apparently continuing as a zigzag line; this postcubital area extremely narrow, mostly 1-celled.

ASCALAPHIDÆ

SUBPALASCA PRINCEPS Gerstaecker.

LUZON, Laguna Province, Mount Maquiling, April 16, 1930 (*V. J. Madrid*), June 15, 1931 (*Emilio Ocampo*).

MANTISPIDÆ

EUCLIMACIA GUERINI Westwood.

LUZON, Laguna Province, Los Baños, February 10, 1929 (*L. B. Uichanco*); Mount Maquiling, July 22, 1925 (*Entomology student*).

EUMANTISPA STRENUA Gerstaecker.

LUZON, Nueva Ecija Province, Bongabon, December 26, 1934 (*Angel Huertas*).

CLIMACIELLA LUZONICA Weele.

LUZON, Laguna Province, Los Baños, August 6, 1923 (*E. M. Sibal*).

MANTISPA LUZONENSIS Navas.

LUZON, Laguna Province, Los Baños, October 27, 1933 (*T. Araneta*); Mount Maquiling, altitude 92 meters, June 16, 1932 (*V. J. Madrid*).

MANTISPA ENDERLEINI Banks.

LUZON, Laguna Province, Los Baños, June 11, 1917 (*C. S Banks*), October 27, 1933 (*T. Araneta*).

AUSTROMANTISPA MANCA Gerstaecker.

LUZON, Laguna Province, Los Baños, April 9, 1926 (*C. G. Manuel*), June 2, 1923 (*S. M. Cendaña*).

RHYACOPHILIDÆ

AGAPETUS CURVIDENS Ulmer.

MINDORO, Mindoro Province, April 11 and 12, 1923 (*L. B. Uichanco*).

HYDROPSYCHIDÆ

VIGARRHA TIBIALIS Navas.

LUZON, Laguna Province, Los Baños, March 17, 1915, many specimens (*C. S. Banks*), August, 1927 (*L. B. Uichanco*). NEGROS, Occidental Negros Province, La Carlota Central, March, 1930 (*L. B. Uichanco*). MINDANAO, Surigao Province, April 20, 1936 (*L. B. Uichanco*).

DIPSEUDOPSIS BAKERI Banks.

LUZON, Laguna Province, Los Baños, very common, every month of year, February 25, 1924 (*A. Damian*), June 14, 1915 (*C. S. Banks*), July 12, 13, and 19, 1922 (*L. B. Uichanco*), July 15, 1915 (*C. S. Banks*), July 22, 1922 (*S. Pagcaliuag*), September 5, 1915 (*G. C. Zabella*), September 30, 1915 (*J. Trinidad*), October 4, 1930 (*A. Siason*), October 8, 1931 (*M. Legaspi*), December 3, 1930 (*C. Valdez*).

DIPSEUDOPSIS NERVOSA Brauer.

LUZON, Laguna Province, Los Baños, April 8, 1917 (*L. G. Mendoza*), July 2, 1923 (*G. B. Ingalla*), November 5, 1924 (*A. Muyargas*).

DIPSEUDOPSIS LUCTUOSA Banks.

MINDANAO, Agusan Province, Jabonga, Mayogda, April 21, 1936 (*L. B. Uichanco*). LUZON, Laguna Province, Los Baños, August 24, 1915 (*F. W. Ashton*), November 14, 1924 (*M. Tadle*), December 16, 1923 (*E. Quisumbing*).

POLYPLECTROPUS ULMERI Banks.

LUZON, Laguna Province, Los Baños, March 17, 1915 (*C. S. Banks*), May 10, 1915 (*C. S. Banks*), June 28, 1922 (*L. B. Uichanco*).

DIPLECTRONA FASCIATA Ulmer.

LUZON, Laguna Province, Los Baños, April 15, 1923 (*G. Lacuesta*).

DIPLECTRONA COSTALIS Banks.

LUZON, Laguna Province, Los Baños, March 17, 1915 (*C. S. Banks*), July 11, 1923 (*T. Reveche*).

CHEUMATOPSYCHE MASIA Navas.

LUZON, Laguna Province, Los Baños, July 13, 1925 (*F. Reveche*), August 12, 1923 (*J. M. de Vera*), September 8, 1917 (*C. S. Banks*), September 20, 1925 (*G. C. Bermejo*), October 191– (no other data). NEGROS, Occidental Negros, La Carlota Central, March, 1930 (*L. B. Uichanco*).

ECNOMUS TAGALENSIS Banks.

This neuropteroid was described as a *Nyctophylax*, and *Ecnomus viganus* Navas is the same species. It is fairly common in Luzon. Superior appendages long, cylindrical, subparallel, with stout, short bristles on inner side; inferior appendages a little more than one-half as long as superior, broadened toward base, toward tip incurved and pointed.

Ulmer has based an identification of a different species on a drawing sent to Navas. But Navas in his original description says that the superior appendages are long, cylindrical (while the figure of Ulmer does not show such an appendage), that the inferior appendages are also elongate, dilated near the base, and toward tip plainly attenuate and clawlike (Ulmer's figure shows a short, broad appendage, broad at tip, not at all attenuate).

I propose for the species Ulmer called *E. viganus* the name *Ecnomus morotus*. Mindanao.

ECNOMUS RIZALI Banks.

LUZON, Laguna Province, Los Baños, May 21, 1923 (*S. M. Cendaña.*)

POLYMORPHANISUS SEMPERI Brauer.

LUZON, Laguna Province, Mount Maquiling, altitude 600 meters, April 19, 1937 (*V. J. Madrid*) ; Los Baños, October 30, 191— (*G. D. Cazenas*).

GUNUNGIELLA MARGINALIS sp. nov.

Hair on head and thorax gray; antennæ pale, darker toward tip, more or less annulate with dark; legs and spurs pale. Forewings in appearance whitish through middle, margined with deep black fringe along costa and outer border, behind with gray fringe. Middle of wing with fine yellowish and black hair, just before outer margin a band of golden hair, and a black fringe around outer margin, elsewhere gray. Head with large, high, posterior warts, ocelli and palpi as in other species. Wings slenderer than in *G. reducta* or *G. nietneri;* thus lower side of fork five hardly one-fourth as long as upper side; in hind wings noticeably more slender and more pointed; fork five larger, fork two longer.

Length of forewing, 4 millimeters.

MINDANAO, Davao Province, Mount Mayo, January 26, 1929, 4,000 to 5,000 feet (*C. S. Clagg*).

Type, M. C. Z. No. 23195.

PSYCHOMYIELLA ULMERI sp. nov.

Head with pale grayish hair, basal joint of antennæ dark, beyond pale, faintly annulate with dark, antenna from middle to tip dark. Front of thorax with pale-gray hair; legs and spurs pale; abdomen dark. Forewings gray, with black and golden hair, fringe near tip of wing very dark, veins here almost black, fringe behind pale, on costa almost black; hind wings gray, with long gray fringe, that on apical half of costa also long and more yellowish. Venation much as in other species; fork three slenderer, fork four very large, fork five plainly shorter than four, lower side not one-half as long as upper side. Hind wings much as in *P. minima,* very slender, apical half (beyond projection) more than twice as long as width at projection; upper side of fork five fully three times as long as lower. In female tip of ovipositor forked; in male lower appendages long, nearly straight.

Length of forewing, 4.2 to 4.5 millimeters.

MINDANAO, Galog River, Mount Apo, altitude 6,000 feet, October 8 and 19, November 4 and 5; Mainit River, altitude 6,000 feet, September 22 and 23, 1929. All collected by C. S. Clagg. Type, M. C. Z. No. 23194.

PADUNIELLA ANGUSTA sp. nov.

Head and thorax with gray hair, some black on sides, antennæ pale, faintly annulate with dark; legs pale, spurs pale; abdomen black. Forewings gray, with some dark and much golden hair, rather darker towards tip; fringe very long, gray, but toward tip nearly black; hind wings pale gray, with very long gray fringes. Forewings rather more slender than in *semarangensis* or *borneensis;* fork three shorter, discal cell shorter. In hind wing base fairly broad, two clear areas broader than in other species, and I cannot find any vein parallel to the base of fork five, but this vein is rather heavy. In the clear costal space a spur vein, much as in *P. africana.* Male appendages yellowish, two long, slender, slightly curved lower pieces, above with a rather broad superior plate, between a pair of slender pieces swollen toward tips; from above projects below a broad, recurved, pointed process.

Length of forewing, female 2.8 millimeters; male, 2.6.

MINDORO, Mindoro Province, San Jose, April 11, 1923 (*L. B. Uichanco*). Type, M. C. Z. No. 23196; paratypes in the College of Agriculture, University of the Philippines.

CALAMOCERATIDÆ

ANISOCENTROPUS MAGNIFICUS Ulmer.

LUZON, Laguna Province, Los Baños, February 26, 1931 (*Gironello*), May 10, 1926 (*S. C. Cendaña*), August 5, 1915 (*L. B. Uichanco*). BASILAN, May 6, 1936 (*Uichanco*).

LEPTOCERIDÆ

NOTANATOLICA GILOLENSIS McLachlan.

LUZON, Laguna Province, Los Baños, many specimens, in every month of the year, but few in August and December, February 10, 1931 (*A. Costes*), April 23, 1928 (*L. B. Uichanco*), June 18 and 23, 1915 (*C. S. Banks*), July 20, 1915 (*C. S. Banks*), July 30, 1922 (*P. Masibay*), August 24, 1915 (*F. W. Ashton*), September 22, 1915 (*C. S. Banks*), October 25, 1915 (*C. S. Banks*), November 14, 1930 (*P. Elayda and R. Denoga*), February 24 (*C. T. Buligan*).

NOTANATOLICA GRISEA Banks.

LUZON, Laguna Province, Los Baños, January 1, 1915 (*J. P. Esguerra*), March 1, 1931 (*D. Tabije*), July 20, 1922 (*A. Gordon*), September 2, 1928 (*A. Severino*), December 16, 1925 (L. *B. Uichanco*).

ŒCETIS APICIPENNIS Banks.

LUZON, Laguna Province, Los Baños, August 15, 1915 (*C. S. Banks*), September 6, 23, and 27, 1915 (*C. S. Banks*).

SETODES SPINOSELLA Ulmer.

NEGROS, Occidental Negros Province, La Carlota Central, March, 1930 (*L. B. Uichanco*).

ŒCETINELLA CONFLUENS Ulmer.

LUZON, Laguna Province, Los Baños, October 25, 1922 (*L. B. Uichanco*).

SERICOSTOMATIDÆ

GŒRA LONGISPINA Ulmer.

LUZON, Laguna Province, Los Baños, December 15, October 17, 1915 (*C. S. Banks*).

GŒRA TAGALICA Banks.

LUZON, Laguna Province, Los Baños, September 20, June 29, 1915 (*C. S. Banks*).

ILLUSTRATION

PLATE 1

FIG. 1. *Psocus rizali* sp. nov.; forewing.
2. *Psocus illotus* sp. nov.; forewing.
3. *Paduniella angusta* sp. nov.; male genitalia, side.
4. *Gunungiella marginalis* sp. nov.; hind wing.
5. *Paduniella angusta* sp. nov.; fore and hind wings.
6. *Paduniella angusta* sp. nov.; male genitalia, below.
7. *Ecnomus tagalensis* sp. nov.; male genitalia, above and below.
8. *Psychomyiella ulmeri* sp. nov.; hind wing and part of forewing.
9. *Stenopsocus jocosus* sp. nov.; forewing.
10. *Psychomyiella ulmeri* sp. nov.; male genitalia, side.

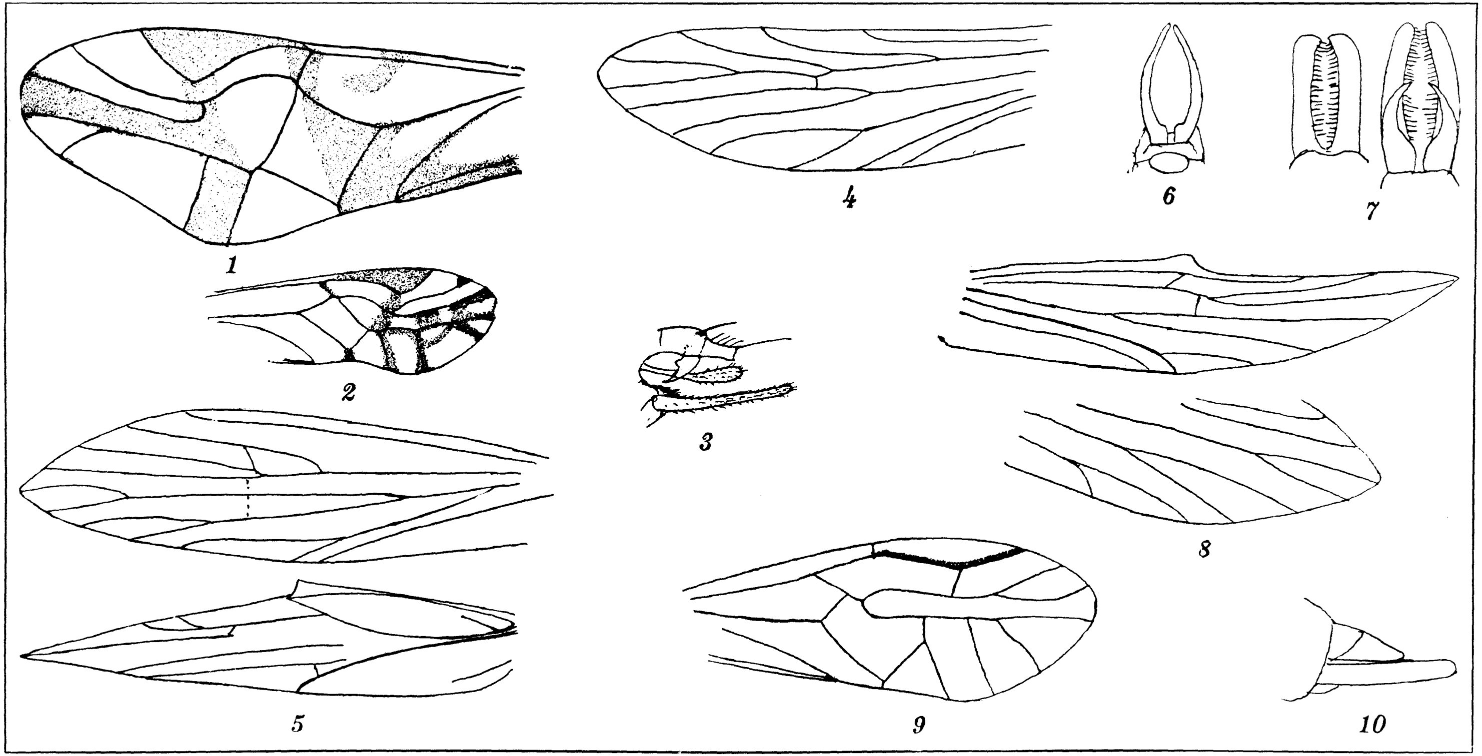

PLATE 1.

A CONTRIBUTION TO OUR KNOWLEDGE OF GORPIS STÅL (HEMIPTERA: NABIDÆ)

By H. M. Harris
Of Ames, Iowa

ONE TEXT FIGURE

In a former paper [1] I pointed out some of the difficulties one meets in attempting to identify specimens of the genus *Gorpis* Stål, and presented a catalogue of the species. Through the kindness of the authorities of the British Museum of Natural History, and especially of Mr. W. E. China, it now becomes possible to make a further contribution to our knowledge of the group.

GORPIS LONGISPINIS sp. nov.

Pale, yellowish testaceous tending toward orange; basal two antennal segments, femora toward apex, and tibiæ toward base flecked or tinged with orange-red; disc of hind lobe of pronotum, scutellum, and median longitudinal stripe to tip of hemelytra darker; humeral spines piceous black above. Head, measured to collum, one-half longer than broad (30: 21), length of anteocular part measured to apex of antenniferous tubercule slightly greater than width of eye; vertex wide (10). Eye proportions, length : width : depth, 9 : 5.5 : 8. Antennal formula 62 : 80: 77: 33; segment I stout, thickly clothed with long, rather coarse, obliquely rising hairs whose length is about three times diameter of segment, segment II with equally numerous but distinctly shorter hairs. Rostral formula, 27: 24: 12. Pronotum longer than broad (49: 41); collar long (5), indistinctly but coarsely punctate; front lobe small, as long as broad (19); hind lobe prominently raised above front lobe, sharply expanded laterally, very thickly, coarsely punctate, humeri armed with a long tapering horn which projects obliquely outward and upward. Scutellum small, slightly broader than long (15: 14), not noticeably produced at apex. Hemelytra narrow, extending beyond apex of abdomen, claval commissure short (25). Ante-

[1] Philip. Journ. Sci. 43 (1930) 415.

rior legs as seen from side rather slender, coxa about three times as long as thick (34: 11), femur nearly ten times as long as deep (96: 10). Male clasper as in text fig. 1, *e*.

Length, 11.8 millimeters; width, 1.81.

Holotype, male, India, United Provinces, Naini Tal, 6,400 feet, April 7, 1934 (*J. A. Graham*); in the collection of the British Museum of Natural History.

This form seems nearest *acutispinis* Reuter and *humeralis* (Distant), and belongs to the same section of the genus. From Reuter's description of the former it differs in color, in that

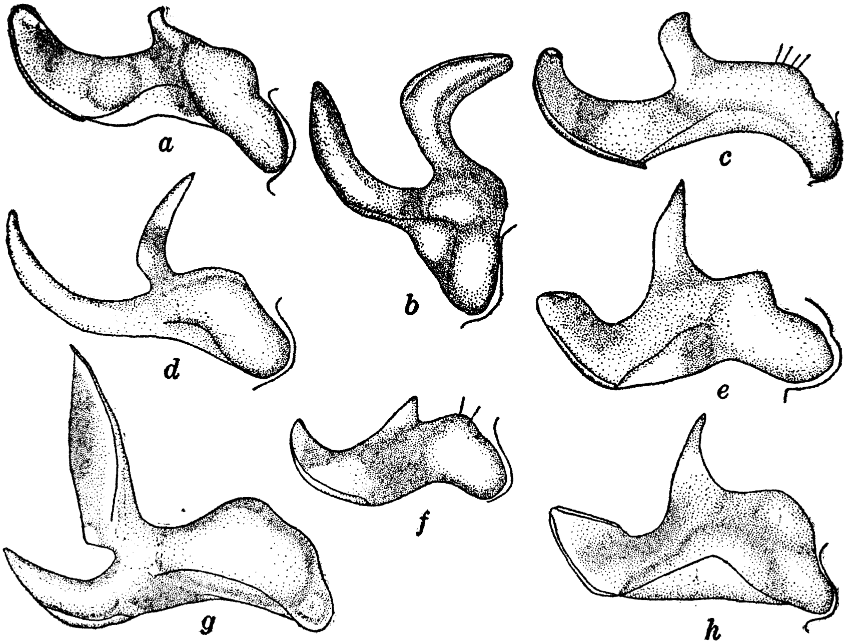

FIG. 1. Left clasper of males of various species of *Gorpis*. *a*, *Gorpis papuanus* sp. nov.; *b*, *G. clavatus* sp. nov.; *c*, *G. simillimus* sp. nov.; *d*, *G. chinai* sp. nov.; *e*, *G. longispinus* sp. nov.; *f*, *G. neglectus* sp. nov.; *g*, *G. transvaalensis* Schouteden; *h*, *G. rufinervis* Poppius.

antennal segment I is equal in length to pronotum and scutellum combined, the pronotum is distinctly longer than broad, and the fore femur is distinctly longer than pronotum and clavus taken together. It agrees with Distant's description and figure of *humeralis* in the proportional length of antennal segment I and in the nature of the antennal clothing, but differs in that the humeral spines are much longer and sharper; there is no evidence of a transverse fascia on the hemelytra, and the front coxæ are longer and their acetabula more inflated.

GORPIS TRANSVAALENSIS Schouteden.

Gorpis transvaalensis SCHOUTEDEN, Rev. Zool. Afr. 6 (1919) 241.

Head longer than broad (male, 31: 20), vertex broad (10). Eyes small, length distinctly less than width of vertex, 8: 5: 7. Antennæ long, segment I relatively thin along basal third, then rather suddenly and noticeably thickened, clothed with a few moderately long pale hairs, 44: 52: 58: 29. Pronotum as long as broad (41: 41), anterior lobe distinctly margined laterally, its disc with cicatrices shiny, darkened, and quite conspicuous; posterior lobe barely raised above anterior, very thickly coarsely punctate, punctures very irregular in size, base deeply emarginate in front of scutellum, margin of the prolonged part on each side of scutellum slightly reflexed. Scutellum as broad as long. Costal margin of hemelytra strongly sinuate. Front coxæ relatively short and stout, less than three times as long as thick (28: 11). Anterior femur only about six times as long as deep (78: 13). Abdomen strongly widened at middle, connexivum prominently maculate. Male clasper as in text fig. 1, *g*.

SOUTH AFRICA, East Cape Province, Kathberg, 4,000 feet, 8 specimens, October, 1932 (*R. E. Turner*); Natal, Malvern, 1 specimen, May 26, 1897 (no collector); Durban, 1 specimen, 1897 (no collector); 1 specimen, 1903 (*W. H. Bell Marley*); Karlkloof, 4 specimens, no date (no collector).

These specimens agree in most details with Reuter's description of *G. apicalis* from Kilimandjaro. They have a large basal spot on the outside of the anterior femora, unmentioned in Schouteden's description and no doubt comparable to the third ring on the femur of Reuter's species. In three of the individuals (teneral) from Karkloof this basal spot is not noticeable, and in all the specimens the middle ring is incomplete above.

GORPIS CHINAI sp. nov.

Pale flavous, conspicuously marked with reddish brown to dark brown. Head irregularly brown above and beneath, with an interrupted irregular stripe on each side above, a spot on middle of column, and a narrow interrupted stripe on each side below, pale; gula darkest. Narrow base of second antennal segment (ring joint) brown, and a conspicuous ring at its tip black. Pronotum variegated, sides of front lobe and margins behind humeri darkest; front lobe mostly brown, with an oblique pale spot on each side in front of transverse impression (this

pale area at times occupies most of the disc so that only sides and median stripe of front lobe are darker) ; posterior lobe with a triangular patch on each side of median line, lateral edges and a narrow oblique line on each side of disc darker. Scutellum brown, a spot on each side and median line usually distinctly paler, apex reddish.

Hemelytra with clavus and a characteristic pattern on corium and base of membrane brown, remainder pale, hyaline. Legs pale, front femur with a broad brown ring in front of distal two-fifths; an elongate postmedian spot and a narrow subapical, incomplete ring on hind femur and a basal ring on hind tibia, brown. Mesosternum and mesopleura largely embrowned with irregular pale areas. Metasternum and abdomen immaculate.

Head longer than broad (male, 22:17), vertex wide (8). Eyes small, 7:4:8. Antennal proportions, 40:44:35:24; segment I with few pale hairs, noticeably enlarged along distal third. Rostral formula, 22:20:12. Pronotum distinctly shorter than broad (34:40), anterior lobe narrow, together with collar as long as posterior measured at midline; hind lobe raised above anterior, thickly punctate, its hind margin broadly concave, slightly reflexed on each side. Scutellum, small, not longer than broad. Hemelytra constricted before middle, then strongly widened, pale area of corium minutely punctulate, membrane extending well beyond apex of abdomen. Front coxa barely more than three times as long as broad (28:9), front femur about five times as long as deep (60:12). Male clasper as in text fig. 1, *d*.

Length, 7.6 to 7.9 millimeters; width, 1.86.

Holotype, male, and allotype, female, Malvern, Natal, South Africa, July, 1897, in the collection of the British Museum of Natural History. Paratypes, 1 male and 1 female, taken with type; 1 male, Durban, Natal, 1897; 1 female, Hilton, November, 1897.

GORPIS SIMILLIMUS sp. nov.

Pale yellowish white; eyes, ocelli, and ring toward apex of hind femur reddish, tips of first two antennal segments, apical half of segment III, tip of rostrum, apices of tibiæ and tarsi, spot at apex of claval commissure, streak along lateral margins of front lobe of pronotum, an indistinct spot at distal third of front femur on its posterior (exterior) side, and three small irregular spots exteriorly on front femur proximal to its middle, embrowned to testaceous. Head longer than broad (25:20),

vertex (10) flatter than in *clavatus*. Eyes more oval than in *clavatus*, 9: 5: 8. Antennæ long, segment I of equal thickness throughout, with a few fine short hairs, 51: 70: 78; segment IV absent. Rostrum stout, with only a few, very fine, short hairs; formula, 30: 25: 12.

Pronotum barely longer than broad (38: 37), not noticeably pilose, collar long, indistinctly punctate, anterior lobe suddenly raised above collar, arched; median constriction deep, posterior lobe strongly raised above anterior, thickly, rather finely and regularly punctate, punctures rounded; base feebly emarginate. Scutellum moderate, faintly longer than broad, tip pointed. Hemelytra subhyaline, almost parallel-sided, margins with only a few fine hairs. Anterior coxæ elongate, over five times as long as thick (42: 8). Front femur as long as head, pronotum and scutellum (except tip) conjoined, nearly seven times as long as deep (89: 13). Abdomen elongate, not expanded distally. Male clasper as in text fig. 1, *c*.

Length, 9.5 millimeters; width, 1.75.

Holotype, male, New Hebrides; Malekula, January, 1930 (*L. Evelyn Cheesman*); in the collection of the British Museum of Natural History.

This species seems nearest *G. flavicans* Harris from Luzon.

GORPIS CLAVATUS sp. nov.

Pale yellowish white; ocelli and eyes reddish, base of antennal segment II (ring joint), tip of rostrum, and tip of tarsi fuscous. A streak on each side of base of head, a short line to each side of center of disc of scutellum, margin of clavus along basal half of commissure, a streak along apical part of claval suture and margin of membrane (forming an X when hemelytra are at rest), a small spot on membrane before apex of corium, two spots on each side of anterior femur (the one at basal fourth indistinct, the other beyond the middle), and an indistinct spot before apex of hind femur, testaceous or embrowned; an apical ring on antennal segment II piceous. Head (measured to collum) longer than broad (male, 26: 18). Vertex (8) arched. Eyes small, 8: 5: 3. Antennæ with few hairs, segment I distinctly enlarged along apical two-fifths; 40: 45: 56: 32. Rostral formula, 25: 20: 13.

Pronotum not longer than broad (39: 38), its sides and propleura conspicuously clothed with long pale hairs; collar long, punctate; posterior lobe coarsely rugosely punctate, punctures elongate; base only feebly sinuate. Scutellum small, as

broad as long, tip short, fine, slightly recurved. Hemelytra shiny, hyaline, constricted on basal third, then strongly expanded; costal margin noticeably ciliate; membrane strongly surpassing tip of abdomen. Fore coxæ only about three times as long as thick (27: 9). Fore femur stout, about six times as long as deep (66 : 11), its length equal to head and pronotum conjoined. Abdomen slightly expanded distally. Male clasper as in text fig. 1, *b*.

Length, 9.2 millimeters; width, 1.7; hemelytra, 2.1.

Holotype, male, and allotype, female, South Africa, Malvern, June 17, 1897, in the collection of the British Museum of Natural History. Paratype, 1 male, taken with types.

GORPIS RUFINERVIS Poppius.

Gorpis rufinervis POPPIUS, Ann. Mus. Zool. Acad. Sci. 19 (1914) 138.

Head longer than broad (32 : 21); vertex broad (9). Eye, 11 : 6 : 9. Antennæ stout; segment I thinner on basal fourth, conspicuously clothed with stout, dark hairs, 55 : 70 : 71 : 27. Rostrum with stout, almost erect dark hairs on basal half; formula, 25 : 21 : 13. Pronotum longer than broad (53 : 48), punctures of hind lobe quite coarse and tending to be elongate, shoulders tumid, basal margin faintly sinuate. Scutellum injured but apparently not noticeably longer than broad. Hemelytra only faintly widened posteriorly, membrane extending well beyond apex of abdomen. Fore coxæ stout, only about three times as long as thick (32 : 10). Front femur nearly eight times as long as deep (92 : 12), slightly longer than head and pronotum conjoined. Clasper as in text fig. 1, *h*.

Length, 13.2 millimeters (11.7 to apex of venter); width, 2.2 (2.6 across hemelytra).

SOUTH AFRICA, Pinesoun (?), May, 1917, Marley; Natal, Kloof, 1,500 feet, 1 male, August, 1926, no collector.

These individuals are mutilated and somewhat teneral, and show only faint evidence of the dark hemelytral markings described by Poppius. They agree with the description in all other respects, however, and thus are tentatively referred to *rufinervis*. They are larger and noticeably stouter than a specimen of *G. cribraticollis* from Ceylon in my collection, and have much stouter antennæ and fore coxæ. The eyes are less sharply rounded exteriorly, and the pronotum is longer and broader and is inflated within the humeral angles.

GORPIS SORDIDUS Reuter.

Gorpis sordida REUTER, Ann. Ent. Soc. Belg. 52 (1909) 428.
Gorpis sordidus HARRIS, Philip. Journ. Sci. 43 (1930) 419, fig. 1, *c*.

PAPUA, Mafulu, 4,000 feet, 4 specimens, January, 1934 (*L. Evelyn Cheesman*); Oquali, 4,500 feet, July, 1933; Mondo, 5,000 feet, January, 1934. These specimens are of especial interest because Reuter's types were from New Guinea. The clasper of the male appears to differ slightly from that of a specimen in my collection from Los Baños, Luzon.

GORPIS PAPUANUS sp. nov.

Color and pattern as in the very closely allied *G. sordidus* Reuter, but recognizable by its larger size, larger eyes, longer antennæ and legs, and slightly differently formed male clasper.

Head (measured to collum) longer than broad (male, 27: 24), interocular distance (9) slightly greater than length of an eye, anteocular part not as porrect and swollen as in *longispinis*. Eye, length: width: depth, 10: 7.5: 10.5. Antennæ very long; segment I of equal diameter throughout its length, clothed with a few fine, short hairs; segments, 72: 103: 130: 32. Rostral formula, 35: 37: 15. Pronotum as long as broad (40: 40), front lobe smooth, somewhat arched, sharply raised above collar; hind lobe thickly, moderately finely, punctate, slightly impressed on each side next to humeri, base broadly, shallowly concave. Scutellum obviously longer than broad, apex slightly produced and swollen. Hemelytra opaque, only feebly expanded beyond apex of clavus; membrane, except along base, hyaline; extending well beyond tip of abdomen. Anterior coxa about seven times as long as thick (58: 8) and almost as long as pronotum and scutellum conjoined. Anterior femur about eight times as long as thick (105: 13), swollen below and slightly concave above, its tibia distinctly bowed, its tarsus very long. Tergum with segments margined with crimson. Male clasper as in text fig. 1, *a*.

Length, male, 10.7 millimeters, female, 11.8; width, 1.8 to 2.1.

Holotype, male, and allotype, female, Kokoda, Papua, 1,200 feet, August, 1933 (*L. Evelyn Cheesman*); in the collection of the British Museum of Natural History. Paratypes, 1 male and 2 females, taken by Miss Cheesman at the type locality in April; 2 males, taken in May; 2 males and 2 females, taken in June; 2 females, taken in September; 1 female, collected at Ishurova, 3,000 feet, July, 1933.

Because of its very apparent kinship with *G. sordidus*, which occurs on the same island but apparently at higher altitudes, this form should be of interest to students of distribution in its relation to speciation.

GORPIS NEGLECTUS sp. nov.

Pale yellowish white, eyes, ocelli, apical ring on hind tibia, and two spots on each side of anterior femora reddish to crimson. Head longer than broad (24 : 20), vertex about as in *simillimus*. Eyes smaller than in *simillimus*, 8 : 5.5 : 8. Antennæ with segment I of about equal thickness throughout its length, with sparse, short, fine hairs; proportions of segments, 46 : 62 : 73 : 35. Rostrum stout, 25 : 20 : 12. Pronotum (37 : 37) about as in *simillimus*; hemelytra slightly broader and with more nearly parallel sides, claval commissure shorter, its length equal to distance across eyes. Anterior coxæ only about four times as long as thick (35 : 9). Front femur about six times as long as deep (75 : 12), with irregular crimson areas at middle and apical fifth. Male clasper as in text fig. 1, *f*.

Holotype, male, Australia, Lordsborough (*H. Hacker*), March 31, 1934; in my collection.

In many respects this form seems nearest *Gorpis simillimus* and *G. philippinensis* Harris. It may be readily recognized from these, however, by the characters pointed out above as well as by the distinctive clasper of the male.

GORPIS BREVILINEATUS (Scott).

Nabis brevilineatus SCOTT, Ann. & Mag. Nat. Hist. (4) 14 (1874) 445.

Gorpis suzukii MATSUMURA, Thousand Insects Japan Addit. 1 (1913) 179.

Gorpis suzukii FUKUI, Kontyu (2) 2 (1927) 85, pl. 5, fig. 29.

Nabis brevilineatus FUKUI, Kontyu (2) 2 (1927) 87.

Gorpis brevilineatus ESAKI, Kontyu 3 (1929) 224.

Professor Esaki has pointed out that the insect called *Gorpis suzukii* by Matsumura is identical with Scott's *Nabis brevilineatus* from Japan. The Matsumura citation did not appear in the various abstracted journals until a late date, and the species was thus unfortunately omitted from my catalogue of *Gorpis*.[2]

[2] Loc. cit.

ILLUSTRATION

TEXT FIGURE

Fig. 1. Left clasper of males of various species of *Gorpis*. *a*, *Gorpis papuanus* sp. nov.; *b*, *G. clavatus* sp. nov.; *c*, *G. simillimus* sp. nov.; *d*, *G. chinai* sp. nov.; *e*, *G. longispinus* sp. nov.; *f*, *G. neglectus* sp. nov.; *g*, *G. transvaalensis* Schouteden; *h*, *G. rufinervis* Poppius.

HELOTIDÆ OF JAPAN, KOREA, AND FORMOSA (COLEOPTERA)

By HIROMICHI KÔNO
Of the Entomological Institute, Hokkaido Imperial University Sapporo, Japan

The family Helotidæ is represented by only one genus, *Helota* MacLeay.

Genus HELOTA MacLeay

Helota MACLEAY, Annul. Jav. (1825) 42.
Neohelota OHTA, Ins. Mats. 4 (1929) 68. (*n. syn.*)

After examining the types of *Neohelota tsumaaka* Ohta, *Neohelota miwai* Ohta, and *Helota sonani* Ohta, all of which are preserved in the Entomological Institute of Hokkaido Imperial University, I am convinced that *Neohelota tsumaaka,* the genotype of genus *Neohelota* Ohta, is the male of *Helota helleri* Ritsema, and *Neohelota miwai* is the male of *Helota sonani* Ohta. Furthermore, the type of *Helota sonani,* which Ohta designated as the male, is in reality the female of the species. Consequently I am of the opinion that *Neohelota* Ohta should be regarded as a synonym of *Helota* MacLeay, because the characters given for the former are merely sexual ones of less than generic value.

1. **HELOTA THORACICA Ritsema.**

Helota thoracica RITSEMA, Notes Leyd. Mus. **18** (1896) 49; **34** (1912) 51; MIWA, Syst. Cat. Formosan Col. (1931) 60.
Helota feæ Ritsema ab. *mushana* OHTA, Inst. Mats. **3** (1929) 108, 109; MIWA, Syst. Cat. Formosan Col. (1931) 59. (syn. nov.)
Helota sp. KATO, Bunrui Genshoku Nippon Konchu Zukan **9** (1833) pl. 6, fig. 6.

Distribution.—Formosa; Tibet.

2. **HELOTA OBERTHÜRI Ritsema.**

Helota Oberthüri RITSEMA, Notes Leyd. Mus. **11** (1889) 110; KATO, Bunrui Genshoku Nippon Konchu Zukan **9** (1933) pl. 6, fig. 5.
Helota oberthüri MIWA, Syst. Cat. Formosan Col. (1931) 60.

Distribution.—Formosa (after Miwa); India.

3. **HELOTA GEMMATA Gorham.**

Helota gemmata GORHAM, Trans. Ent. Soc. Lond. (1874) 448 (*pars*); REITTER, Verh. Naturf. Ver. Brünn **16** (1876) 65, pl. 1, figs. 1–5;

HAROLD, Abhandl. Naturf. Ver. Bremen **5** (1876) 119; LEWIS, Col. Cat. Jap. Archip. (1879) 11; WATERHOUSE, Aid Ident. Ins. (1882) pl. 133, fig. 2; OLIFF, Cist. Ent. **3** (1883) 52, pl. 3, fig. 8; SCHÖNFELDT, Cat. Col. Jap. (1887) 94; RITSEMA, Notes Leyd. Mus. **11** (1889) 104; Ann. Mus. Civ. Genova **30** (1891) 888; LEWIS, Entomologist **26** (1893) 150; RITSEMA, Entomologist **26** (1893) 183; Junk Col. Cat. 34 Helotidae (1911) 105; MATSUMURA, Thous. Ins. Jap. **3** (1905) 51, pl. 43, fig. 3; Konchu Bunruigaku **2** (1905) 184; JACOBSON, Käfer Russ. West-Eur. (1905–1913) 900; WINKLER, Cat. Col. reg. pal. **6** (1926) 714; OHTA, Ins. Mats. **3** (1929) 110; YOKOYÁMA, Nippon no Kochu (1930) 116, pl. 15, fig. 2; MATSUMURA, 6000 Ill. Ins. Jap. (1931) 141, fig. 202; Ill. Comm. Ins. Jap. **3** (1931) 32, pl. 8, fig. 11; YUASA, Nippon Konchu Zukan (1932) 711, fig. 1395; KAMIYA and ADACHI, Genshoku Kochu Zufu (1933) pl. 16, fig. 3; KATO, Genshoku Nippon Konchu Zukan **9** (1933) pl. 6, fig. 8.

Distribution.—Japan, Hokkaido, Honshu, Shikoku, Kiushu.

4. **HELOTA FULVIVENTRIS Kolbe.**

Helota fulviventris KOLBE, Arch. f. Naturg. 52 (1886) 182, pl. 11, fig. 25; RITSEMA, Notes Leyd. Mus. **11** (1889) 104; LEWIS, Entomologist **16** (1893) 183; JACOBSON, Käf. Russ. West-Eur. (1905–1913) 900, pl. 24, fig. 24; RITSEMA, Junk Col. Cat. **34** Helotidae (1911) 105; WINKLER, Cat. Col. reg. pal. **6** (1926) 714; OHTA, Ins. Mats. **3** (1929) 108, 109; MATSUMURA, 6000 Ill. Ins. Jap. (1931) 141, fig. 201; Ill. Comm. Ins. Jap. **3** (1931) 33, pl. 8, fig. 15.
Helota japonica OHTA, Ins. Mats. **3** (1929) 108, 109; MATSUMURA, 6000 Ill. Ins. Jap. (1931) 141, fig. 203. (*n. syn.*)
Helota fulviventris ab. *awana* OHTA, Ins. Mats. **3** (1929) 108, 109.

Distribution.—Japan, Honshu, Shikoku, Kiushu; Korea; Amur.

5. **HELOTA GORHAMI Oliff.**

Helota Gorhami OLIFF, Cist. Ent. **3** (1883) 53, 56; KOLBE, Arch. f. Naturg. **52** (1886) 181; RITSEMA, Notes Leyd. Mus. **11** (1889) 192; Junk Col. Cat. 34 Helotidae (1911) 105; JACOBSON, Käf. Russ. West-Eur. (1905–1913) 900; WINKLER, Cat. Col. reg. pal. **6** (1926) 714.
Helota gòrhami OHTA, Ins. Mats. **3** (1929) 108, 109.

Distribution.—Korea; China.

6. **HELOTA SINENSIS Oliff.**

Helota sinensis OLIFF, Cist. Ent. **3** (1883) 54, pl. 3, fig. 3; MIWA, Syst. Cat. Formosan Col. (1931) 60.

Distribution.—Formosa (after Miwa); China.

7. **HELOTA YEZOANA sp. nov.**

Helota cereopunctata OHTA, Ins. Mats. **3** (1929) 108 (*pars*); MATSUMURA, 6000 Ill. Ins. Jap. (1931) 141, fig. 200.

Upper surface of body dark bronze, somewhat coppery shiny; four elytral spots yellow. Antennæ testaceous, slightly infuscated toward base. Under surface mostly reddish testaceous, head (except throat) and elytral epipleuræ metallic green, lateral portions of meso- and metasterna pitchy brown. Femora at apical third and tibiæ metallic green; tarsi and claws pitchy brown.

Head strongly and rather densely punctured. Prothorax trapezoidal, widest at base; lateral edges distinctly crenulate; base bisinuate, hind angles acute; anterior angles somewhat produced and rounded; upper surface at sides strongly and densely punctured, with some scattered punctures near middle, except impunctate longitudinal central portion. Scutellum small, transverse, impunctate. Elytra nearly parallel, rounded posteriorly, each with ten regular, punctured striæ; interstices impunctate, 1st, 2d, 6th, and 8th interstices costate on apical portion; anterior yellow spot occupying interstices of 4th, 5th, and 6th striæ; posterior yellow spot placed between 3d and 6th striæ. Underside of head (with exception of impunctate throat) and lateral portions of thorax distinctly punctured. Legs on metallic portions distinctly punctured. Anterior tibiæ strongly curved, shallowly furrowed along under side. Abdomen smooth, finely punctured; last ventral segment subtruncate at apex and provided with a tomentose impression.

Length, 7.5 millimeters.

Holotype, female, Jozankei, Hokkaido, June 2, 1935, *H. Kôno.*

Paratype, male, Jozankei, Hokkaido, September, 1908, *S. Matsumura.*

This species resembles *Helota cereopunctata* Lewis, from which it differs in the slenderer body and in the reddish testaceous lateral portions of the prothorax.

8. **HELOTA CEREOPUNCTATA Lewis.**

Helota cereo-punctata LEWIS, Ent. Month. Mag. 17 (1881) 225; RITSEMA, Junk Col. Cat. 34 Helotidae (1911) 104.

Helota cereopunctata RITSEMA, Entomologist 26 (1893) 183; JACOBSON, Käf. Russ. West-Eur. (1905–1913) 900; WINKLER, Cat. Col. reg. pal. 6 (1926) 714.

Distribution.—Honshu (after Lewis).

9. **HELOTA TAIWANA Ohta.**

Helota taiwana OHTA, Ins. Mats. 4 (1929) 66; MIWA, Syst. Cat. Formosan Col. (1931) 60.

Neohelota pusilla KATO (*nec* Oberthür, Bunrui Genshoku Nippon Konchu Zukai 9 (1933) pl. 6, fig. 1, 2. (syn. nov.)

Distribution.—Formosa.

10. HELOTA HELLERI Ritsema.

Helota helleri RITSEMA, Notes Leyd. Mus. 34 (1912) 51.

Helota helleri OHTA, Ins. Mats. 3 (1929) 108, 109; MIWA, Syst. Cat. Formosan Col. (1931) 59.

Neohelota tsumaaka OHTA, Ins. Mats. 4 (1929) 66, 68; MATSUMURA, 6000 Ill. Ins. Jap. (1931) 141, fig. 204; MIWA, Syst. Cat. Formosan Col. (1931) 60. (syn. nov.)

Distribution.—Formosa.

11. HELOTA SONANI Ohta.

Helota sonani OHTA, Ins. Mats. 4 (1929) 66, 67, female (no male); MIWA, Syst. Cat. Formosan Col. (1931) 60.

Neohelota miwai OHTA, Ins. Mats. 5 (1931) 136; MIWA, Syst. Cat. Formosan Col. (1931) 60. (syn. nov.)

Helota fexæ ab. *mushana* KATO (*nec* Ohta), Bunruin Genshoku Nippon Konchu Zukan 9 (1933) pl. 6, fig. 6; MIWA, Syst. Cat. Formosan Col. (1931) 59.

Distribution.—Formosa.

12. HELOTA MONTANA Ohta.

Helota montana OHTA, Ins. Mats. 4 (1929) 66, 67; MIWA, Syst. Cat. Formosan Col. (1931) 60.

Distribution.—Formosa.

13. HELOTA SEMIFULVA Ritsema.

Helota semifulva RITSEMA, Notes Leyd. Mus. 3 (1881) 80; MIWA, Syst. Cat. Formosan Col. (1931) 60.

Distribution.—Formosa (after Miwa); Java.

TWO RARE PEDICULATE FISHES FROM THE PHILIPPINES

By ANTOLIN G. AGCO

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ONE PLATE

This paper is a systematic account of two rare Philippine fishes based on three specimens trawled from a depth of 30 fathoms in the China Sea in the vicinity of San Narciso, Zambales Province. These specimens form a part of the ichthyological collection of the Fish and Game Administration, Bureau of Science, Manila.

LOPHIIDÆ

ANGLERS

Body contracted, conical, tapering sharply backwards from shoulders. Skin mostly smooth, naked, with many dermal flaps about head. Head wide, depressed, exceedingly large. Mouth very large, terminal, opening into an enormous stomach; upper jaw protractile; maxillary without supplemental bone; lower jaw projecting, both jaws with very strong, unequal, depressible cardiform teeth, some caninelike. Vomer and palatines usually with strong teeth. Spinous dorsal of 3 isolated, tentaclelike spines on head, and 3 smaller spines behind, forming a continuous fin; second dorsal moderate, similar to anal. Pectoral membranes scarcely geniculated, each with 2 actinosts and elongate pseudobrachia. Ventrals jugular I, 5 widely separated. Branchial apertures comparatively large, in inferior axils of pectorals. Gills 3, without gill rakers. Pseudobranchiæ present.

Carnivorous fishes living at moderate or great depths of temperate and tropical seas in the Pacific, Atlantic, and Indian Oceans.

Genus LOPHIOMUS Gill

Lophiomus GILL, Proc. U. S. Nat. Mus. 5 (1882) 552.

Head large, depressed, subcircular, occupying most of body, with several spines. Teeth in lower jaw mostly in 3 series, anteriorly in 4 series. Opercular membrane without free pos-

terior margin. Gill openings wide below pectorals, extending beyond them posteriorly. Pectorals broad, with 22 or 23 rays, bases retractible into branchial apertures. Spinous dorsal with six spines. Soft dorsal with 8 rays; anal with about 6 rays, last ray cleft to base and supported by a single basal bone. Vertebræ about 19.

LOPHIOMUS SETIGERUS (Vahl).

Lophius setigerus VAHL, Skrivt. Naturh. Selsk. IV 1 (1797) 215.
Lophius viviparus BLOCH and SCHNEIDER, Syst. Ichth. (1801) 142.
Lophius indicus ALCOCK, Journ. Asiatic Soc. Bengal 58 (1889) 302; Descriptive catalogue of Indian Deep-Sea Fishes in Indian Mus. (1899) 53.
Lophiomus setigerus JORDAN and EVERMANN, Bull. U. S. Nat. Mus. 47 pt. 3 (1898) 2714; REGAN, Ann. & Mag. Nat. Hist. 11 (1903) 282; WHITLEY, Rec. Aust. Mus. 16 (1927–1929) 236.

Head, 2; dorsal, I, I, I, III—8; pectoral, 22; ventral, I, 5; anal, 7; caudal, 7.

Head as broad as long. Mouth terminal, wide, oblique, lower lip extending beyond upper, exposing lower teeth. Teeth small, unequal, depressible on jaws; two series in upper, an outer row of smaller teeth and an inner twice as long; lower jaw with irregular series mostly in 3 rows, 4 rows anteriorly. One or two strong teeth on each side of vomer; four or five in palatine. Anterior part of tongue whitish, with a network of black lines. Eye small, slightly less than interorbital space. Snout 2.3 in head, with characteristic concavity in front of eye, bordered by two strong spines anteriorly. Operculum with four spines, three at preopercle, one at superior angle of opercle. First spine of preopercle at edge of disc pointing forward, other two outward. Other spines of head, two short ones behind angle of mouth, two in supraorbital, four in postorbital, three on medial ridge bordering concavity before eye, two at occiput, one at ridge between head and humeral process. Humeral spine trifid, first point vertical, other two directed posteriorly. Gills three; gill openings transverse, wider than eye, below pectorals, at hind edge of disc.

Spinous dorsal modified, composed of somewhat isolated spines. Foremost dorsal spine, a bristle with fleshy bait, reaching base of third dorsal spine. Second dorsal spine shorter than first, fringed throughout. First and third longest. Base of soft dorsal 2.5 in head. Pectorals broad with rounded mar-

gin, length about equal to distance from mouth to hind margin of eye. Ventrals small, 1.7 in caudal. Origin of anal below fourth ray of soft dorsal. Caudal subtruncate, 5.4 in total length.

Alcoholic specimens brownish olive, dermal flaps darker; ventral surface whitish.

Described from No. 31936, 63 mm, and No. 31937, 55 mm, trawled by M/L "Science I" from a depth of 30 fathoms in the China Sea off San Narciso, Zambales Province, Luzon, Philippine Islands, February 10, 1937. These are the first Philippine specimens taken of this genus and species.

Known to inhabit certain depths of the sea from the coast of Malabar to the seas of China and Japan.

OGCOCEPHALIDÆ

BAT FISHES

Head very broad and depressed, snout more or less elevated; trunk short and slender, mouth small, subterminal or inferior, lower jaw included, teeth villiform or cardiform. Gill openings very small, above and behind axils of pectorals. Body and head covered with bony tubercles or spines. Spinous dorsal reduced to a small rostral tentacle which is retractile into a cavity under a prominent process on forehead. Soft dorsal and anal small and short, ventrals well developed. Pectoral base strongly angled with long pseudobrachia and 3 actinosts. Branchiostegals 5. No pseudobranchiæ.

Fishes inhabiting warm waters of the Atlantic, Pacific, and Indian Oceans.

Genus HALIEUTOPSIS Garman

Halieutopsis GARMAN, Mem. Mus. Comparative Zoöl. Harvard **24** (1899) 89.

Head wide, broadly rounded forward; rostrum and skull raised above balance of disclike head. Snout indented; subopercular region much swollen. Eyes small. Rostral niche deep; rostrum overhanging; illicium protractile and depressible, esca with two large spherical bulbs and a median slender bifurcated more mobile portion. Mouth medium, anterior, overhung by swollen margins. Teeth absent from vomer, palatines, and apparently from tongue. Subopercular process and spines well developed. Gills two, none on first and fourth arches.

HALIEUTOPSIS VERMICULARIS Smith and Radcliffe.

Halieutopsis vermicularis SMITH and RADCLIFFE, Proc. U. S. Nat. Mus. 42 (1912) 209; KAMOHARA, Annot. Zool. Japon. (1) 16 (1937) 12.

Head, 1.7; depth, 3; dorsal, 4; pectoral, 11; ventral, 5; anal, 3; caudal, 6.

Body short, slender, tapering posteriorly. Head comparatively broad, depressed, subcircular. Mouth small, subterminal. Jaws subequal, upper slightly protruding forward. Narrow band of villiform teeth in jaws and tongue, absent from vomer and palatines. Snout equal to eye, bluntly rounded anteriorly. Nostrils moderate, lying in a depression in anterior margin of rostrum. Illicial niche less than eye diameter, overhung by arched rostrum which projects beyond jaws. Illicium trilobed, two basal wedge-shaped bulbs and an upper median spherical lobe. Eye small, 5 in head. Interorbital equal to eye, troughlike, deep. Gill openings small, well ahead of pectoral base, forward and toward side of tail. Gills 2, gill rakers short, fleshy tubercles, six on lower arch of first.

Dorsal surface covered with stellate tubercles capped with spines. Minute tubercles between large ones. Rostral spines strong, an erect median spine overhanging tentacular cavity, with one lateral oblique bicuspid spine on each side. Large tubercles on sides of disc with bifid and trifid spinules. Ventral surface of disc naked, except for small spinous tubercles below mandible and minute fleshy tubercles scattered all around ventrally.

Soft dorsal origin about midway between occiput and tip of caudal, longest rays 5 in standard length. Pectorals 1.9 in head. Ventrals as long as soft dorsal, set wide apart. Anal inserted below soft dorsal base, its length 2 in pectoral. Caudal truncate, 2 in width of head.

Alcoholic specimens grayish olive; dorsal surface with olive vermiculations; tips of soft dorsal, anal and caudal dusky, ventral surface colorless.

Here described from specimen No. 31935, 34 mm long, trawled by M/L "Science I" at a depth of 30 fathoms off San Narciso, Zambales Province, Luzon, Philippines, February 10, 1937.

ILLUSTRATION

PLATE 1

FIG. 1. *Lophiomus setigerus* (Vahl); dorsal view.
2. *Halieutopsis vermicularis* Smith and Radcliffe; dorsal view.
3. *Lophiomus setigerus* (Vahl); ventral view.
4. *Halieutopsis vermicularis* Smith and Radcliffe; ventral view.

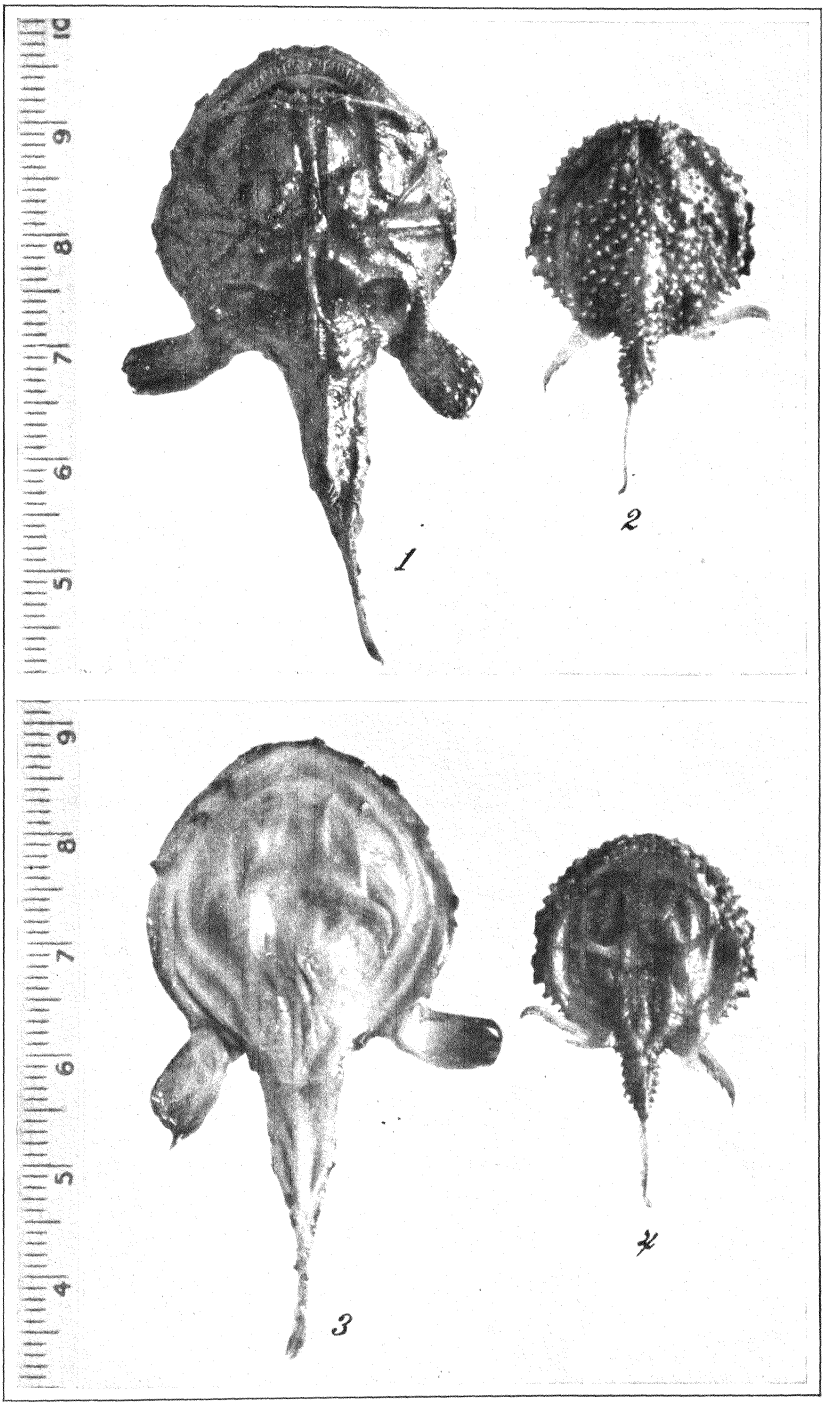

PLATE 1.

TWO NEW DECAPODS FROM THE PHILIPPINES

By GUILLERMO J. BLANCO

Of the Fish and Game Administration, Bureau of Science, Manila

TWO PLATES

In this paper are given the descriptions of two new Philippine species of *Palæmon.* The specimens of *P. lagdaoensis* were collected from the brackish portions of Cagayan River at Aparri, March, 1938. Those of *P. talaveræ* were collected by Mr. Florencio Talavera from Sampaloc Lake, San Pablo, Laguna Province, February 25, 1931.

The classification of the smaller varieties of Philippine palæmons is still lacking. In 1914 R. P. Cowles described ten species of fresh-water palæmons. The specimens described were mostly of larger varieties of prawns. Recently a new species of marine *Palæmon* from northern Luzon was described. This brings up to a total of thirteen the number of *Palæmon* species known to inhabit the seas and inland waters of the Philippines.

Genus PALÆMON Fabricius

Rostrum well developed, laterally compressed, toothed above and below. Carapace smooth, furnished with antennal and branchiostegal or hepatic spines. Pterygostomian spine wanting. Mandible with 3-jointed palp.

PALÆMON LAGDAOENSIS sp. nov. Plate 1.

Rostrum short, slightly curved upwards a little beyond antennal scale; rostral $\frac{6}{5\text{–}6}$-dentate, 6 prominent teeth on upper margin, only 1 tooth on carapace, behind orbital margin; 5 to 6 teeth on lower margin; tip bifid. Carapace smooth; antennal and branchiostegal spines present; supraorbital and hepatic spines absent; pterygostomian angle rounded. Eyes slender, twice as long as wide, cornea 2.5 times its dorsal length; ocellus brownish to blackish. Mandible with molar and incisor process with 3-jointed palp (Plate 1, fig. 2). Maxillule cross-shaped, distal margin of lacinia with spinelike structures and setæ, endopodite thumblike (Plate 1, fig. 3). Third maxilliped with hair structures, reaching beyond ischium of first peræopod.

Lateral process of basal segment of first antennular peduncle ending in acute spine, reaching beyond middle of next segment. Outer antennular flagellum as long as inner flagellum. Antennal scale parallel-sided, 2.5 times as long as broad; outer margin straight, terminating with acute spine.

First peræopods equal in size and length, reaching beyond antennæ scale by their chela or reaching tip of rostrum. Chela with tufts of hairs; 3 times in carpus; mobile and immobile fingers with minute spines at cutting edge. Fingers as long as palm. Second peræopods equal in size and length, long, reaching beyond rostrum by tip of merus and chela. Chela, with tufts of hairs, 1.25 times in carpus, cutting edge of mobile finger with three teeth, of immobile finger with one tooth (Plate 1, fig. 4), fingers as long as palm.

Third, fourth, and fifth legs similar, fifth longer than third or fourth. Dactylus of third and fourth slightly curved; dactylus of fifth leg much curved. Propodus twice as long as carpus; posterior borders armed with slender spines in pairs.

Body robust in female, dorsally rounded. Abdominal pleura rounded in first to third somites; fourth and fifth acutely pointed behind. Sixth abdominal somite longer than fifth; breadth twice in dorsal length. Pleopods moderate, usually foliaceous. Telson tapering, with two pairs of curved spines dorsally. Apex of telson with rounded corners pointed at tip with two short equal externolateral spines and two long internolateral spines; between them a pair of setæ. Uropods each with a distinct spine.

Type locality.—Cagayan River. Specimens caught in scissor nets.

Color.—Live specimens yellowish brown with pink eggs in female. Specimens in alcohol yellowish pink.

Measurements.—Several specimens collected from Cagayan River within vicinity of Bisugu, Aparri, Cagayan, March, 1938, ranging from 32 to 40 mm, from tip of rostrum to tip of telson.

This new species is named *lagdaoensis* after the word *lagdao*, the local name for small fresh-water or brackish-water forms of prawns.

PALÆMON TALAVERÆ sp. nov. Plate 2.

Rostrum short, slightly curved, a little beyond antennal scale, $\frac{8\text{–}11}{3\text{–}4}$ -dentate, 8 to 11 prominent teeth on upper edge, two teeth on carapace, one behind orbital margin, the other just above

eye orbit; tip not bifid. Carapace smooth; antennal and hepatic spines present; branchiostegal spine wanting; pterygostomian angle rounded. Eyes slender, two times as long as wide, cornea 2.5 times its dorsal length.

Mandible with molar and incisor process with 3-jointed palp (Plate 2, fig. 2). Third maxilliped reaching beyond ischium of first peræopod. Lateral process of basal segment of first antennular peduncle ending in acute spine, reaching beyond middle of next segment. Outer antennular flagellum as long as inner flagellum. Antennal scale 3.5 times as long as broad, outer margin nearly straight, terminating in acute spine.

First peræopods equal in size and length, reaching beyond antennal scale and reaching beyond tip of rostrum. Chela with tufts of hairs (Plate 2, fig. 3); mobile and immobile fingers with minute spines at posterior cutting edge. Fingers a little longer than palm. Second paræopods equal in size and length, long, reaching beyond rostrum by one half of merus and chela. Chela without tufts of hairs; 1.2 times in carpus; cutting edge of mobile finger with two teeth; of immobile finger with three teeth (Plate 2, fig. 4); fingers as long as palm. Third, fourth, and fifth peræopods similar, fifth slightly longer than preceding two. Dactylus of fifth peræopod curved, third and fourth slightly curved. Propodus twice as long as carpus; posterior borders armed with slender spines in pairs.

Body not robust, dorsally rounded. Abdominal pleura rounded in first, second, and third somites, fourth and fifth acutely pointed behind. Pleopods moderate in size, usually foliaceous. Sixth abdominal somite as long as fifth dorsally. Telson tapering with two pairs of dorsal spines and one spine at apex. Apex of telson not rounded, corners pointed at tip, with two short equal externolateral spines, and two long internolateral spines, and in between three unequal long setæ. Uropods each with a distinct spine.

Type locality.—Sampaloc Lake, San Pablo, Laguna Province, Luzon.

Color.—Specimens in alcohol yellowish.

Measurements.—Several specimens collected from Sampaloc Lake, San Pablo, Laguna Province, range from 17 to 35 mm in length, from tip of rostrum to tip of telson.

The specific name is given in honor of Mr. Florencio Talavera, who is responsible for the identification of most of the carcinological collections of the Bureau of Science.

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ILLUSTRATIONS

[Drawings by Guillermo J. Blanco.]

PLATE 1. PALÆMON LAGDAOENSIS SP. NOV.

FIG. 1. Female, lateral view; × 3.5.
2. Mandible with palp; × 30.
3. Maxillule; × 30.
4. Portion of chela of second walking leg; showing cutting edge; × 30.
5. Dorsal portion of telson, showing dorsal spines; × 30.
6. Terminal portion of telson; × 50.

PLATE 2. PALÆMON TALAVERAE SP. NOV.

FIG. 1. Male, lateral view; × 3.5.
2. Mandible with palp; × 30.
3. Chela of first walking leg; × 30.
4. Portion of chela of second walking leg, showing cutting edge; × 30.
5. Dorsal portion of telson, showing dorsal spines; × 30.
6. Terminal portion of telson; × 60.

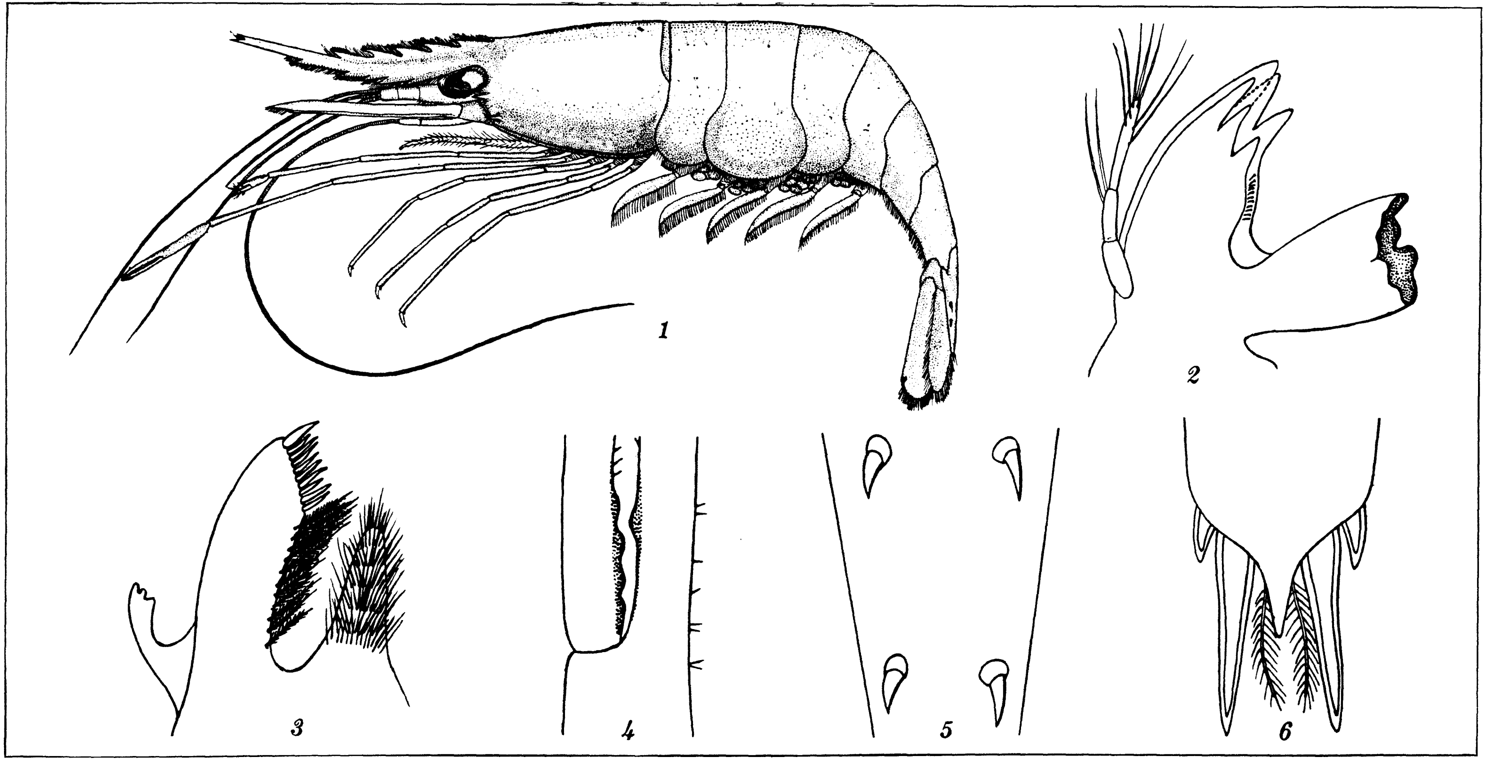

PLATE 1. PALÆMON LAGDAOENSIS SP. NOV.

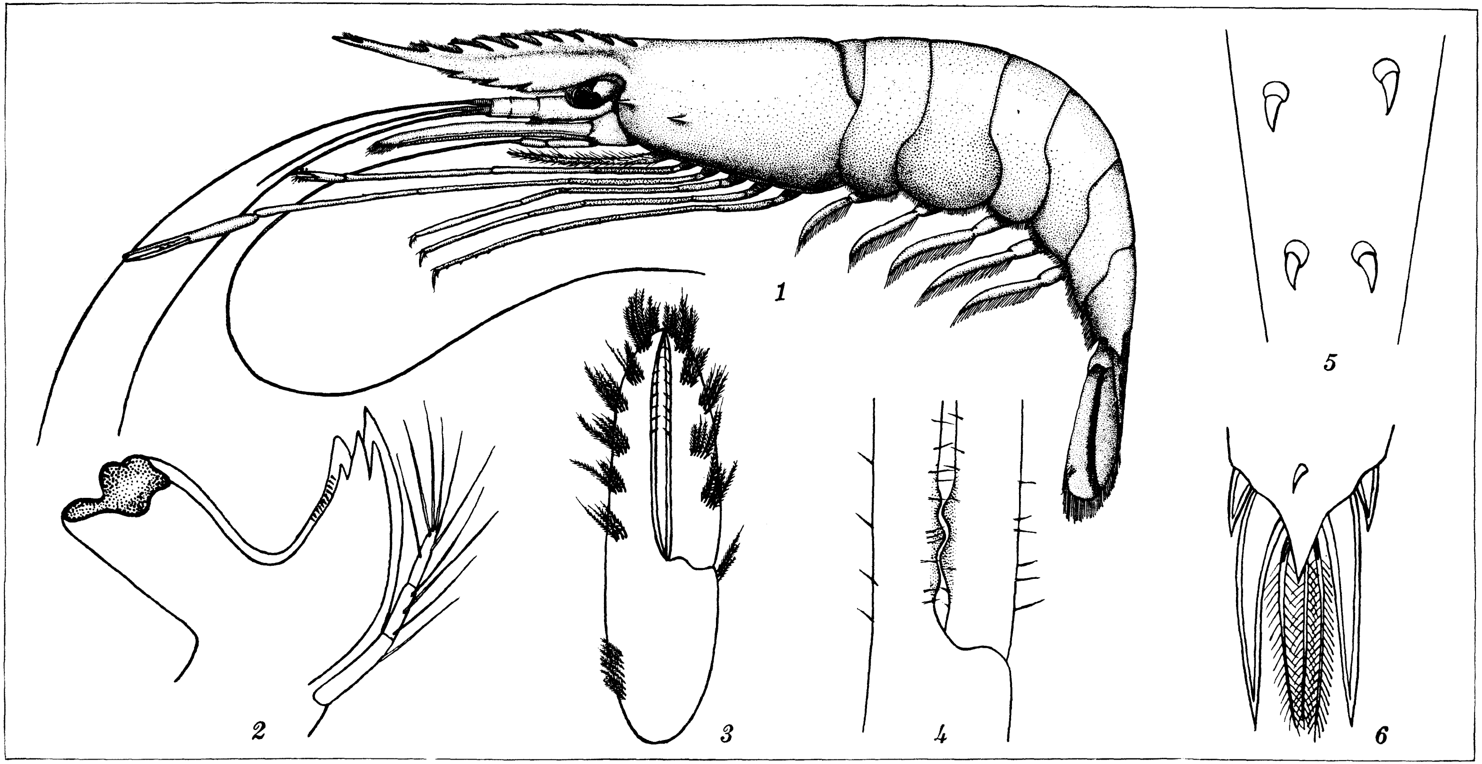

PLATE 2. PALÆMON TALAVERÆ SP. NOV.

SNAIL FISHING AND DUCK RAISING IN LAGUNA DE BAY, LUZON

By FELIX J. ARRIOLA and DOMICIANO K. VILLALUZ

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FOUR TEXT FIGURES

Since 1918 there has been a noticeable increase in the capital invested in the duck industry in Laguna de Bay. At present there are no less than 300,000 duck layers kept in the various towns bordering the lake. It is claimed that this progress in the duck industry has been attained as a result of the introduction and use of the *kaladkad* (text fig. 1, *a*) system of gathering snails. Previous to 1918 the *pañgahig* (text fig. 1, *b*) was employed by the duck raisers for snail fishing. The rapid increase in the number of birds kept and fed mostly with snails eliminated the use of this device, for it was inefficient and difficult to operate.

The kaladkad system which is now extensively used in snail fishing is being carefully studied to determine its relation to the fauna of the lake in general, with the extent of the snail fishery, and the effects of this industry on the other fishing gear employed in the lake.

SNAILS AS FEED FOR DUCKS

Mollusks represent the bulk of food of domesticated ducks kept around Laguna de Bay. People engaged in this industry maintain that the only way to raise these birds profitably is to feed them wholly or partially with snails. Alonte (1930) reported that approximately 2 or 3 *kaengs* of *Vivipara angularis* (*susong pangpang*) are consumed by 100 ducks a day. One kaeng contains approximately from 50,000 to 60,000 mature snails, or an average of 55,000. The 300,000 duck layers consume, therefore, an average of 7,500 kaengs or 412,500,000 snails a day, a comparatively large quantity taken from the small snail-bed area available in the lake.

Because of the scarcity of *V. angularis*, several other species of shells are gathered in large quantities. Among these are

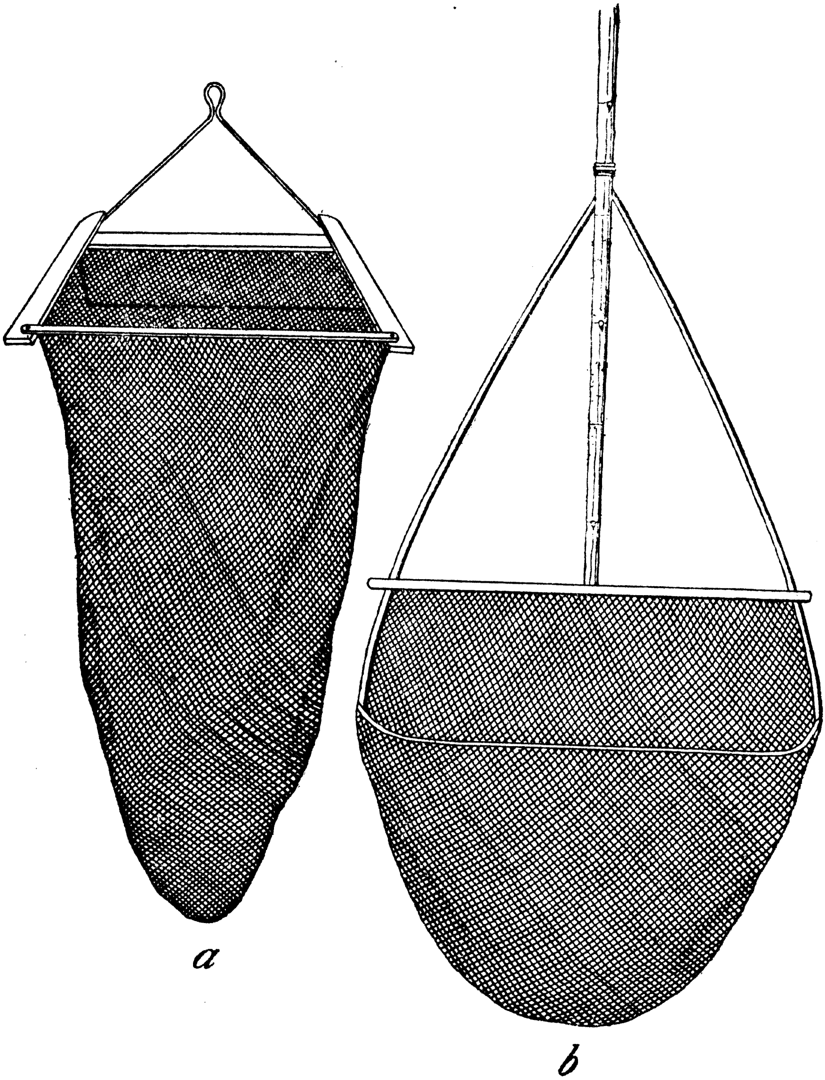

FIG. 1. Snail-fishing gear used in Laguna de Bay. *a*, Kaladkad; *b*, pañgahig.

Ampullaria luzonica Reeve (Ampulariidæ); *Melania lateritia* Lea, *M. scabra* Müller, *M. pantherina* van den Bosch, and *M. asperata* Lamarck (Melaniidæ); and *Corbicula manillensis* Philippi (Cyrenidæ).

SNAIL POPULATION OF LAGUNA LAKE

The snail population in the lake has a wide distribution. From the edge to the middle of the lake *V. angularis*, together

with other species of shells, are known to thrive. The best breeding ground for *V. angularis* and the several species of *Melania,* however, is the muddy bottom of the lake from where the bulk of snails are hauled. *Corbicula manillensis* is known to inhabit sandy and stony bottoms. Thus the amount of this shell caught by the kaladkad is insignificant, as this gear cannot be operated in such places.

The area of Laguna de Bay is 930.7 square kilometers, and the area open for the kaladkad fishermen is placed at about

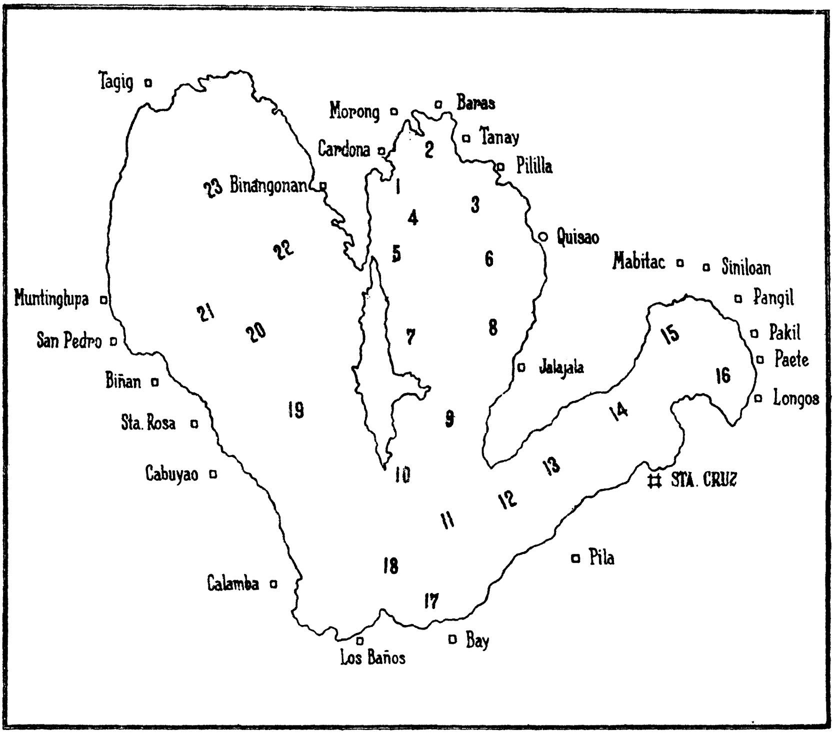

FIG. 2. Map showing the number of *V. angularis* per square meter, taken at random in Laguna de Bay.

850 square kilometers. The remaining 80.7 square kilometers are either occupied by fish corrals and various kinds of bamboo fish traps, or have sandy and gravelly bottom. Snail fishing in the latter region is very inconvenient, due to the obstructions met with in the operation of the kaladkad. Furthermore, the operation of any fishing gear within a radius of 100 meters from the fish corrals is prohibited. In spite of the wide area open for the kaladkad fishermen, however, many of them are hauling snails within prohibited zones.

Snail fishermen when interviewed about the relative abundance of snails in the lake confirmed the finding that the snails are becoming scarcer from year to year. The snail supply in the open portions of the lake is so low that even if snail fishing is allowed within prohibited zones the snails procurable are not sufficient to meet present or future demand.

QUANTITY OF VIVIPARA ANGULARIS AVAILABLE

In order to ascertain the approximate *Vivipara angularis* population in Laguna de Bay, 23 plots of 1 square meter each were selected at random, and the snails available on them were taken and counted June 30, 1937. Table 1 and text fig. 2, showing a map of the lake, show the places where the snails were taken. The average number of *V. angularis*, *Melania* spp., and *C. manillensis* per square meter was found to be 18, 318, and 14, respectively. *Melania* spp. and *C. manillensis* were also counted, because they are now being used as substitute for *V. angularis*. They are not, however, as valuable a feed as *V. angularis*, which is considered best for egg production.

TABLE 1.—*Number of Vivipara angularis taken per square meter at random in Laguna de Bay.*

Locality.	Lot No.	*Vivipara.*	*Melania.*	*Curbicula.*	Total.	Depth.
						Ft.
Looc Cove, Cardona	1	2	522	6	530	8
Between Baras and Tanay	2	13	518	57	588	12
Between Pililla and Quisao	3	22	405	8	455	10
Sorosoro	4	5	617	13	636	17
Near mouth of Diablo Pass	5	24	311	0	335	23
Bagumbayan	6	46	427	0	473	12
Between Lambac and Boor	7	10	308	0	318	15
Between Boor and Jalajala Point	8	1	629	8	638	14
Between Balibago and Jalajala Point	9	18	633	5	556	15
Talim Point	10	0	504	12	516	17
Between Jalajala Point and Bay Island	11	23	347	61	431	14
Between Jalajala Point and Pila	12	68	54	0	122	10
Between Jalajala Point and Nanghaya	13	36	221	21	278	8
Between Bagombong and Santa Cruz	14	4	872	7	883	8
Lumbang	15	25	623	68	716	6
Paete	16	43	23	0	66	5
Near Bay Island	17	7	547	6	560	14
Near Calamba Island	18	16	314	0	330	12
Between western side of Talim Island and Santa Rosa.	19	3	216	0	219	10
Between San Pedro and Diablo Pass	20	10	307	17	334	12
Muntinlupa	21	31	212	23	265	7
Binangonan	22	0	321	0	321	6
Darangan	23	11	242	3	256	5
Average		18	318	14		
Total		419	9,173	315		

The following data were used in the present computation of the population of *V. angularis* in Laguna de Bay:

Average number of *V. angularis* per square meter, 18.
Area accessible to kaladkad, 850 sq. km.
Computed *V. angularis* population, 15,300,000,000.
V. angularis consumed daily, 412,500,000.

According to Alonte (1930) *Vivipara angularis* attains sexual maturity at an average length of 19.08 millimeters and an average width of 15.11 millimeters at the age of 63 days. According to the normal expectation in biotic potentiality of organisms, at least one individual out of any given number of offspring reaches sexual maturity. A generation of *V. angularis* lasts about 63 days, so that approximately 5 generations are produced in one year. Thus within a year one snail will give rise to about 32 snails.

The population of *V. angularis*, 15,300,000,000, is divided into 63 lots of 242,900,000 individuals each. For 63 days at least 1 lot reaches sexual maturity per day. The daily withdrawal is also divided into 63 groups, each group assumed to be distributed among each lot of the entire population. Thus 6,560,000 *V. angularis* $\frac{(412{,}500{,}000)}{63}$ are assumed to be taken from each lot daily. By this assumption the consumption is allotted uniformly and the danger of rapid exhaustion of the snail population is avoided. But the daily consumption allotted to each group $\frac{(242{,}900{,}000)}{6{,}560{,}000}$ is contained 37 times in one lot, so that only the first 37 lots have to reproduce once in this present computation. The computation is therefore based on the remaining population of *V. angularis* after a lapse of 37 days.

Table 2 shows that on the first day lot 1 will be doubled, or 485,800,000 *V. angularis*. On the second day all the lots will be diminished by 6,560,000, and the population of lot 2 after reproduction is 472,680,000. From the same table, the population of each lot is given at maturity. The population of lot 1 after deducting the consumption for 37 days is 243,080,000 *V. angularis*, and the population of lot 37 on the 37th day is 6,920,000 so that on the 38th day this lot will be exhausted. The remaining 37 lots, which have reproduced once, will be exhausted after 11 days, because the total population of the 37 lots after 37 days is 4,625,490,000, and divided by 412,500,000 (daily quantity consumed) will give only 11 days. It is safe

to conclude, therefore, that 38 days after June 30, 1937, when the census of the snail population was taken, the population of *V. angularis* will be so small, almost reaching the zero point, that rehabilitation of this species is impossible, especially as long as the people persist on their present practice.

TABLE 2.—*Diminution of first 37 lots that have reproduced once.*

Lot.	Population at maturity.	Days before lot reproduces.	Population after reproduction.	Snails taken in 37 days.	Remaining snails after 37 days.
1	242,900,000	37	485,800,000	242,720,000	243,080,000
2	236,340,000	36	472,680,000	236,160,000	236,520,000
3	229,780,000	35	459,560,000	229,600,000	229,960,000
4	223,220,000	34	446,440,000	223,040,000	223,400,000
5	216,660,000	33	433,320,000	216,480,000	216,840,000
6	210,100,000	32	420,200,000	209,920,000	210,280,000
7	203,540,000	31	407,080,000	203,360,000	203,720,000
8	196,980,000	30	393,960,000	196,800,000	197,160,000
9	190,420,000	29	380,840,000	190,240,000	190,600,000
10	183,860,000	28	367,720,000	183,680,000	184,040,000
11	177,300,000	27	354,600,000	177,120,000	177,480,000
12	170,740,000	26	341,480,000	170,560,000	170,920,000
13	164,180,000	25	328,360,000	164,000,000	164,360,000
14	157,620,000	24	315,240,000	157,440,000	157,800,000
15	157,060,000	23	302,120,000	150,880,000	151,240,000
16	144,500,000	22	289,000,000	144,320,000	144,680,000
17	137,940,000	21	275,880,000	137,760,000	138,120,000
18	131,380,000	20	262,760,000	131,200,000	131,560,000
19	124,820,000	19	249,640,000	124,640,000	125,000,000
20	118,260,000	18	236,520,000	118,080,000	118,440,000
21	111,700,000	17	223,400,000	111,520,000	111,880,000
22	105,140,000	16	210,280,000	104,960,000	105,320,000
23	98,580,000	15	197,160,000	98,400,000	98,760,000
24	92,020,000	14	184,040,000	91,840,000	92,280,000
25	85,460,000	13	170,920,000	85,280,000	85,640,000
26	78,900,000	12	157,800,000	78,720,000	79,080,000
27	72,340,000	11	144,680,000	72,160,000	72,520,000
28	65,780,000	10	131,560,000	65,600,000	65,960,000
29	59,220,000	9	118,440,000	59,040,000	59,400,000
30	52,660,000	8	105,320,000	52,480,000	52,840,000
31	46,100,000	7	92,200,000	45,920,000	46,280,000
32	39,540,000	6	79,080,000	39,360,000	39,720,000
33	32,980,000	5	65,960,000	32,800,000	33,160,000
34	26,420,000	4	52,840,000	26,240,000	26,600,000
35	19,860,000	3	39,720,000	19,680,000	20,040,000
36	13,300,000	2	26,600,000	13,120,000	13,480,000
37	6,740,000	1	13,480,000	6,560,000	6,920,000
38	180,000	0	360,000		
	4,625,490,000				

KALADKAD

The frame of the kaladkad or dredge net is in the form of an isosceles triangle made of cast iron. The base is 3 feet long and the sides are 3.5 feet high each. About 6 inches above

the base and parallel to it is another iron bar, which, together with the base and the lower part of the sides, forms a regular trapezoid. Attached to the upper parallel iron bar and perpendicular to its plane is a rectangular board 5 inches by 24 inches which serves as a regulator of the pressure of the gear against the bottom of the lake during the process of hauling. Around the mouth of the trapezoid is attached a semicircular net (Aguinaldo Standard No. 1) which is in the form of a bag. The vertex of the triangle is provided with a loop where an abaca rope of about $\frac{3}{4}$-inch diameter is hooked. This rope, about 30 yards long, is used in towing the gear.

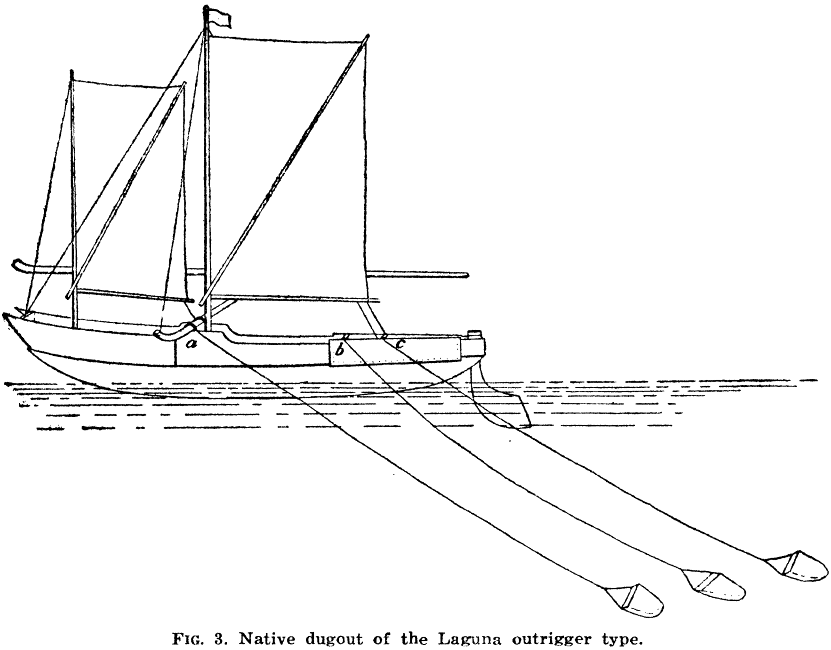

FIG. 3. Native dugout of the Laguna outrigger type.

The boats employed are the native dugouts or bancas of the Laguna-outrigger type with an average capacity of 12 kaengs of shells. They are about 12 yards long with a width of 4 feet and a depth of 3 feet. Each sailboat is usually manned by at least two men employing 2 to 3 dredge nets at a time. One man acts as the steersman, whose main duty is to direct the course of the sailboat. The other two men operate the dredge nets on the hold of the sailboat.

The end of the rope connecting one of the gear is tied around the bamboo crosspiece of the outrigger and the other two around

the two wood crosspieces set far apart on the stern hold of the sailboat (text fig. 3, *a*, *b*, and *c*). The gear are passed out into the water and hauling begins by setting on the sails. The gear are hauled when half full of snails. By pulling the rope every so often an experienced snail fisherman can easily determine

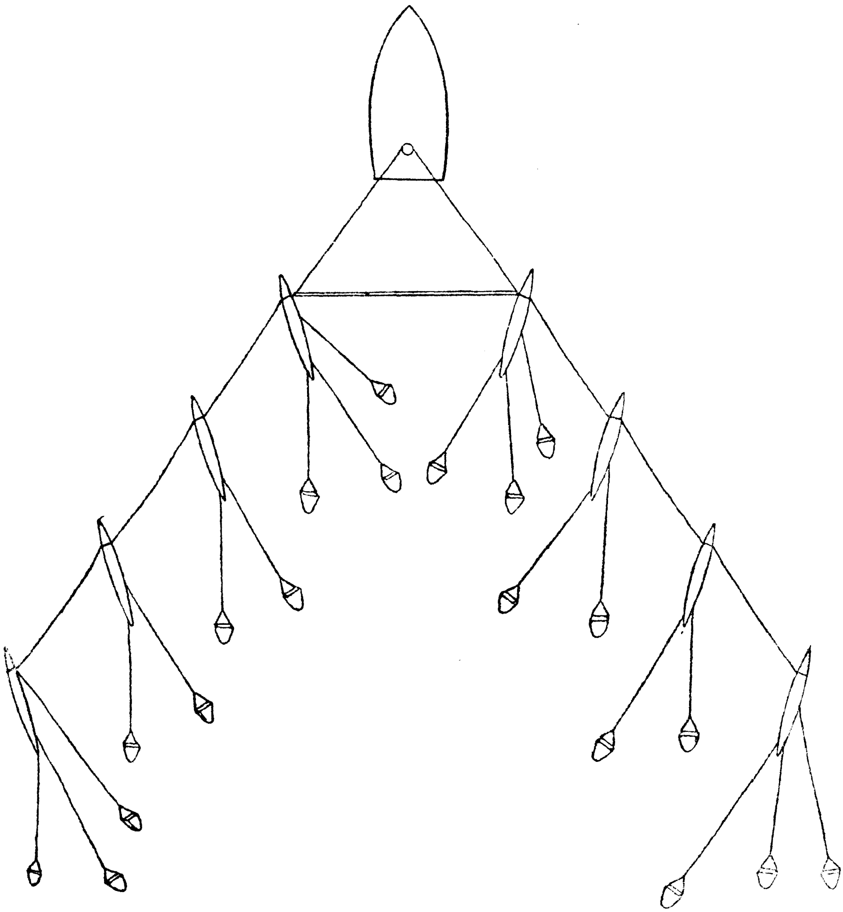

FIG. 4. Motor boat in the action of towing the sailboats each of which drags at least three dredge nets.

when to haul. The shells are cleansed of the mud before they are dumped into the sailboat and the operation is repeated until the required amount of snails is gathered. At least three to four hours are necessary to load a sailboat of a capacity of 12 kaengs.

Sails are used to propel the sailboat whenever the wind blows in a favorable direction. In calm weather the sailboat is propelled with man power—by paddle or by bamboo poles.

Nowadays motor power is used in gathering snails in Laguna de Bay. A motor launch tows from 20 to 30 sailboats, each of which drags at least 3 dredge nets. The sailboats are placed in two lines at intervals of 10 feet, and tied to the rear end of the motor boat. A beam stretched across the first two boats of each line keeps the two lines separate. In actual operation the two lines of sailboats assume an inverted V-shaped arrangement and all the dredge nets are dragged on the inner side of the two lines. This arrangement allows a uniform dredging of the area covered (text fig. 4), and prevents the intertwining of ropes and the passing of any dredge net over an area already hauled by another.

A drege net operated in connection with a motor boat is heavier to haul than one dragged by a sailboat operating alone. The speed of a sailboat may be momentarily slowed down by the lowering or loosening of the sail, which makes the hauling of the dredge net comparatively lighter. In a series of sailboats towed by a motor this is not possible. The motor boat must maintain a constant speed, because any slight slackening in speed will necessarily disturb the arrangement of the bancas as well as the dredge nets.

ILL EFFECTS OF THE KALADKAD

On the fauna of the lake in general.—Any body of fresh water, such as a lake, harbors a particular type of community of plants as well as species of animals or larvæ associated with them. Large plants serve as shelter and protection for aquatic larval stages of insects and larvæ of fishes and other lower forms of life of animals, while large animals feed on the smaller plants and animals at the bottom. As the entire bottom open to the kaladkad is scraped off often to a depth of about 2 to 4 inches, the growth of all kinds of plants and the various animals associated with them is greatly disturbed. Besides, many immature fishes are caught and destroyed with the snails. Among them are young of *biyang puti*, *Glossogobius giurus* (Gobiidæ); *kanduli*, *Arius* spp. (Ariidæ); *ayuñgin*, *Therapon plumbea* (Theraponidæ); and the *bañgayñgay*, *Ophiocara aporos* (Eleo-

tridæ). Crustaceans, fresh-water shrimps, and crabs are also represented in the catch of dredge nets.

Of the fishes mentioned, biyang puti probably suffers the greatest destruction. Newly spawned gobies, which are held in bunches by a gelatinous membrane and attached on the under surface of the mud caves, become detached and destroyed when the kaladkad passes over them.

On the snail fishery.—The amount of snails consumed by more than 300,000 ducks a day (7,500 kaengs, or 412,500,000 snails) is responsible, more than any other factor, for the rapid depletion of snails in Laguna de Bay. In addition to this big amount of *V. angularis* hauled in every day, four causes of less importance influence the scarcity of snails; namely, the kaladkad net used at present being a nonselective fishing gear, the amount of snails wasted in feeding, occurrence of polluted water (*masamang tubig,* Tag.) in various portions of the lake, and the entrance of saltwater into the lake through Pasig River.

The kaladkad, being a nonselective fishing gear, catches snails of all sizes. Even the smallest or newly spawned *V. angularis* are represented in the catch. The immature group of *V. angularis* noted in the catch of kaladkad are on the average 6 millimeters long and 3.56 millimeters wide. The smallest *V. angularis* was 3 millimeters long and 2.51 millimeters wide. This size is about that of a newly spawned *V. angularis.* The mesh opening of the net used is so small that immature individuals of almost all species of shells available in the lake are present in the catch. The catching of these immature snails is very destructive to the snail population, allowing it no chance to reproduce before being gathered.

Due to the insanitary system of storing the snails, more snails are wasted than are actually consumed by the flock. The water used in sprinkling the snails kept in *tiklis* is taken from the swimming pool of the flock. This water is highly polluted on account of the decayed snails and fæces of the ducks, so that instead of refreshing the snails it kills them suddenly. The snails easily rot on account of the insanitary condition of the duck pen. The ducks do not eat rotten snails. If decayed snails are accidentally taken in by the ducks because of hunger, ptomaine poisoning results. The high percentage of mortality among the ducks kept around the lake is primarily attributed to hunger and to the unhealthful condition of the duck pens.

Decayed snails have a very obnoxious odor. Often enormous

numbers of the larvæ and pupæ of flies are left undisturbed for a week in big heaps of rotten snails. Decayed snails serve as ideal breeding ground for flies. Serious outbreak of diseases may thus occur in the localities where ducks are raised.

The occurrence of polluted water in various portions of the lake spells death to the animal forms inhabiting Laguna de Bay. This condition usually occurs near the shore of the lake. During summer, when the water is low, various aquatic plants and organic matter rot along the shore. At the beginning of the rainy season these decayed plants and organic materials are washed off, causing water pollution in the locality. But the most serious cause of water pollution which results in the scarcity of the snail population is the rotting of *lia* (Tag.), a unicellular alga, *Clathrocystis aeruginosa* (Kützing) Henfrey. A very thick slimy cake of this alga is usually formed on the surface of the water during summer. Due to the heat of the sun it decays together with the smaller fishes and organisms. After the decomposition of the algæ the snails have been observed to float on the surface of the water. Polluted water can easily be detected by a very characteristic fœtid odor of the decomposing algæ.

Another factor affecting the snail population is the entrance of salt water into the lake through Pasig River. At high tide a big portion of the lake becomes brackish. A great number of dead *V. angularis* have been observed to float on the surface of the water due to the diffusion of salt water into the lake. According to experienced snail fishermen, *Melania* spp. are not affected by the occasional increase in salinity of the water in the lake.

On other fishing gear.—On account of the pronounced scarcity of snails procurable in the open portions of the lake, snail fishermen are prone to invade even the prohibited zones. Invasion of the shallower parts of the lake results very often in the destruction of fish corrals and bamboo fish traps. Damage to the bamboo fish traps cannot be avoided because their position under the water cannot be detected. As a result complaints have been filed against kaladkad fishermen, and there have been frequent quarrels between kaladkad fishermen and the owners of the fish corrals and bamboo fish traps. Frequent violations of the fishery laws are committed as long as there are snails procurable in the neighborhood of fish corrals and fish traps. The decrease in the catch of these fishing gear is claimed to

be due to the frequent snail fishing which tends to drive schools of fish away.

The gill nets and set lines (with baited hooks) are fishing appliances employed to catch fish at night. They are set in the lake from 2 P. M. to 6 P. M. and hauled in about 3 A. M. Because the kaladkad fishermen are hauling snails day and night, they are a menace to the gill nets and set lines. Very often these fishing gear are never recovered because they are towed several kilometers away from the place of setting. Gill nets and set lines hauled by a kaladkad are often destroyed or rendered useless.

USES OF SNAILS

There are three species of mollusks used as food by the people around Laguna de Bay; namely, *Corbicula manillensis, Ampullaria luzonica,* and *Melania asperata.* The people resort to eating these shells when the price of fish is extraordinarily high. Snails also serve as food for the fishes caught in commercial quantities in the lake. According to Mane (1929) snails rank second in importance among the food of kanduli. In most instances the alimentary canals of commercial fishes have been found to contain nothing but snails and, with the present scarcity of snails, it is feared that the natural food of the fishes in the lake has been greatly reduced. Snails are also used as bait in fishing. In some cases, too, lime is manufactured by burning the shells of *Melania asperata.*

But the most important use of snails in Laguna de Bay is as food for the native ducks. They represent about 90 per cent of the daily diet of the ducks kept around the lake. The progress of the duck industry is at present determined only by the availability of a good supply of snails. The duck industry is bound to decline if the people continue to refuse to look for and buy feeds other than the snails whose supply is now very limited. Duck raisers still persist in the belief that the snails arise spontaneously and cannot be depleted even in the face of the present scarcity. They also have the notion that snails are the only right kind of feed for their flocks. They have altogether disregarded the importance of other protein supplements, such as shrimp and fish meals. Their failure to provide adequate food for the ducks is responsible for the poor supply of eggs in the local markets.

NECESSITY OF FISH-PROTEIN SUPPLEMENT IN THE DIET OF DUCKS

In order to maintain a regular supply of duck eggs, other protein supplements must be introduced. Cruz (1932) reported that snail-fed ducks consume the most feed and are the most expensive to raise. On the other hand, in the ducks which are given protein supplement other than that derived from snails, the production of eggs is more or less controlled. Ducks fed with other protein supplement lay eggs regularly throughout the year.

Fronda and Mencias (1937) reported that the eggs of ducks that depend upon snails for protein supplement in the feed have yolks that are deep orange in color. It is an accepted fact that snail-fed ducks produce eggs with very fishy flavor. In the experiment conducted by Fronda and Mencias (1937) the taste and color of the eggs obtained from ducks fed with mash mixture (see below) compare favorably with chicken eggs. The different kind of mash mixtures are given in Table 3.

TABLE 3.—*Mash mixtures given to ducks by Fronda and Mencias.*

Feeds used.	Lot 1.	Lot 2.	Lot 3.	Lot 4.
	Kg.	*Kg.*	*Kg.*	*Kg.*
Shrimp meal	20.0			
Fish meal		20.0	30.0	40.0
Corn meal	20.0	20.0	17.5	15.0
Rice bran	60.0	60.0	52.5	45.0
Price per 100 kg., in pesos	6.31	5.00	5.75	6.31

To every kilogram of each of the mash mixtures one kilogram of common table salt and two kilograms of ground shells were added. Chopped green grass was added to each lot morning and afternoon. The feed was given four times a day. The ducks were given at each feeding time as much feed as they were able to consume in 20 minutes. According to the experiment, the only water accessible to the ducks at all times was drinking water which was changed four or five times a day. The ducks laid eggs regularly throughout the year. The most economical production of eggs was that of lots 2 and 3, where the cost of feeds needed to produce a dozen eggs was 19 and 23 centavos, respectively. The above mash mixture is at present highly recommended to restore the duck industry around Laguna de Bay.

The duck industry cannot be restored to its former status unless the snail fishery in Laguna de Bay is rehabilitated. Re-

habilitation can only be attained by feeding the ducks in the meantime with protein supplement, such as the mash mixture formulated by Fronda and Mencias in 1937. The duck raiser's only alternative now is to buy protein supplement or abandon the industry.

Duck raisers still consider snails the best feed for ducks. As a matter of fact, the Pateros duck raisers are at present gathering marine species of snails in the vicinity of Malabon and Navotas, Rizal Province. Like the conditions existing at present in Laguna de Bay, the supply of snails in these localities is also limited, so that the cost of producing eggs per unit weight of snail food is extraordinarily high.

SUMMARY AND CONCLUSION

In order to avoid the decline of the duck industry proper conservation of the snail fishery in Laguna de Bay is urgently recommended. Only a limited number of the ducks should be kept and maintained to balance the probable yield of the snails in the lake.

The kaladkad system of snail fishing is very destructive to the fauna of the lake in general, to the snail fishery, and to the other fishing gear employed to catch fish in the lake. The kaladkad net used catches snails of all sizes found in Laguna de Bay. The harmful effect of the kaladkad on the snail fishery, together with the big amount of snails consumed by the ducks every day, are responsible, more than any other factor, for the rapid depletion of snails in the lake.

Snail-fed ducks are expensive to raise. Moreover, duck raisers are not dependent upon snails alone to carry on the enterprise profitably. A more economical feed for egg production should be introduced. Fish protein supplement if given at the rate of 20 to 30 per cent gives the best returns on the cost of feed consumed.

RECOMMENDATIONS

1. That the mesh openings of the kaladkad net be standardized. Every kaladkad fisherman should use the Aguinaldo Standard No. 5.

2. That no kaladkad fisherman be allowed to gather snails at night, in order to give a chance to other fishermen to employ gill nets and set lines.

3. That no fisherman be allowed to gather snails within 200 meters from the fish traps (fish corrals) and 100 meters from bobos to avoid disturbance and damage done to these gear.

4. That only sufficient snails be given to the flock, and the excess supply be placed under water to avoid rotting and decay. Rotting snails must be carefully buried.

5. That no kaladkad be operated at any time of the year in the waters east of Talim Island. This side, belonging to the Municipal waters of Cardona, Jalajala, and Pililla, Rizal Province, is considered the best breeding ground of the commercial food fishes inhabiting Laguna de Bay.

6. That supplementary feed be introduced to obtain the best returns on the feed consumed. Supplementary feed will also improve the eating quality of the eggs.

ILLUSTRATIONS

TEXT FIGURES

THE OCCURRENCE OF FUGACIOUS CAMBIUM IN THE RHIZOME OF CURCUMA LONGA LINNÆUS

By Dhirendra Nath Chakraverti

Of the Botany Department, Carmichael Medical College, Calcutta

TWO PLATES

The rhizome of *Curcuma longa* Linn., of the Zingiberaceæ, shows a cambial activity limited to a very short length of its apical part. Similar fugacious cambium has been recorded by Skutch (7) in the bulb of banana, of the Musaceæ "whose chief function is the origination of the adventive roots and the vascular bundles which link them with the leaf-trace bundles."

To determine the occurrence of fugacious cambium in the rhizome of *Curcuma longa*, old rhizomes of this plant with terminal and lateral buds were kept under moist sawdust for some days. At the end of this period the rhizomes were found to have resumed their growth, and roots had appeared at the base of the lateral buds. These buds were cut off and fixed, some in stock chromoacetic solution, and others in the fixative named "Craf" by Randolph. (5) Materials fixed in stock chromoacetic solution were washed in water, dehydrated in dioxan, and embedded according to Maheswari's review of T. T. Baird. (4) Materials fixed in "Craf" were directly immersed in 75 per cent alcohol, and then dehydrated and embedded in the usual way. Microtome sections in transverse and longitudinal planes were cut 6 to 10 μ thick and stained in safranin and Delafield's hæmatoxylin.

Examination of the sections showed that an undifferentiated meristem marks the extreme apex of the rhizome of *Curcuma longa*, at a little lower level of which some rudimentary primary vascular bundles appear mostly in a ring (Plate 1, fig. 1), together with many older cortical (leaf-trace) bundles on the outside (Plate 2, fig. 2). Soon after the development of the primary vascular cylinder is completed, some of the pericyclic cells at different places undergo one or more periclinal divisions, forming strips of fugacious cambium which may vary from two to four layers of cells. All these strips taken together make up

about three-fourths of the circumference of the section, with occasional interruptions for the passing out of the radially extending leaf-trace bundles (Plate 1, fig. 2). This cambium produces secondary vascular bundles on its inner side only and is found, as thought by Cheadle,(2) to be associated with the production of adventive roots (Plate 1, fig. 3), thus linking the vascular bundles of adventive roots with those of the stele of the rhizome as in the case of the banana.(7, p. 235, fig. 1) The duration of this fugacious cambium is very short; it soon disappears almost abruptly, leaving behind a definite ring which Engler and Prantl(3) refer to as "Die stark in die Augen springende Kreislinie," consisting of a weft of crowded bundles, the output of secondary growth (Plate 2, fig. 3). This ring is observed even with the unaided eye throughout the older portion of the rhizome when the rhizome is cut into thin pieces or slices. The crowded arrangement of the secondary vascular bundles and their distribution in a ring clearly distinguish them from the primary vascular bundles which are loosely arranged and scattered. Similar crowded secondary vascular bundles were recorded by Scott and Brebner(6) in the stem of *Aristea corymbosa* Benth. of the Irideæ.

The primary vascular bundles are closed and collateral (Plate 1, fig. 4) but of the secondary vascular bundles some are collateral (Plate 1, fig. 5) while others are amphiphloic (Plate 1, fig. 6). The sclerenchymatous ring is absent in both the primary and secondary bundles. In size the primary and secondary vascular bundles are variable (Plate 2, fig. 3). In transverse sections oblique and even some longitudinal bundles appear amongst the secondary vascular bundles. The formation of periderm also takes place, but it is very superficial.

Buds arise exogenously at the axils of scaly leaves of the rhizome; in serial transverse sections the peripheral vascular bundles of the axillary buds pass gradually towards the center through the cortex till they become arranged in the same ring of secondary vascular bundles of the rhizome, and thus the circular stele (Plate 1, fig. 1; Plate 2, fig. 2) takes up an oval outline (Plate 1, fig. 2; Plate 2, fig. 3).

In some arboreal forms amongst monocotyledons Arber(1) has recorded a form of cambial thickening which, though differing widely from that of dicotyledons, is yet competent to

[1] Die Nat. Pflanzenfamilien II 6 (1899) 13.

produce secondary growth; it was found in *Aloe, Cordyline, Dasylirion, Dracaena, Kniphofia, Nolina, Yucca, Xanthorrhoea, Agave, Furcraea, Aristea* and related genera, *Testudinaria, Tamus,* and *Dioscorea.* But this cambium was of permanent nature, unlike the fugacious cambium in the rhizome of *Curcuma longa.*

ACKNOWLEDGMENT

This work was carried out under the direction of Dr. S. R. Bose, Professor of Botany of Carmichael Medical College, to whom I am obliged for helpful suggestions and useful criticism.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Rudimentary primary vascular bundles, *pvb*, in a ring around the central ground tissue, *gt*; × 208.

2. Strips of fugacious cambium, *f cam*, secondary vascular bundles of varying shape, *svb*, two spiral vessels, *v*, one vascular bundle, *vb*, passing longitudinally, and endodermis, *en*; × 200.

3. Origin of root, *r*, and secondary vascular bundles, *svb*, from fugacious cambium, *f cam*, in the middle, and very young secondary vascular bundle, *ysvb*, developing from cambium; × 244. Reconstructed from two slides.

4. Closed collateral primary vascular bundle. Xylem, *x*, phloem, *ph*, and protoxylem, *pr x*; × 220.

5. Closed collateral secondary vascular bundle. Xylem, *x*, and phloem, *ph*; × 200.

6. Amphiphloic secondary vascular bundle. Xylem, *x*, phloem, *ph*, and endodermis, *en*, with casparian strips; × 240.

PLATE 2

FIG. 1. Strips of fugacious cambium, secondary vascular bundles, spiral vessels, and endodermis. Eye piece 15 x and low-power objective 16 mm; original photomicrograph reduced to $\frac{2}{3}$.

2. Central ground tissue, *gt*, with a ring of rudimentary primary vascular bundles, *pvb*, and older leaf traces, *lt*, on the outside, two leaf bases, *lb*, attached to the central stem, and small gaps, *g*, at extremity of leaf base. Eye piece 10 x and low-power objective 16 mm; original photomicrograph reduced to $\frac{2}{3}$.

3. Secondary vascular bundles, *svb*, just inside the endodermis, *en*, arranged in a ring, primary vascular bundles, *pvb*, lying in the middle.

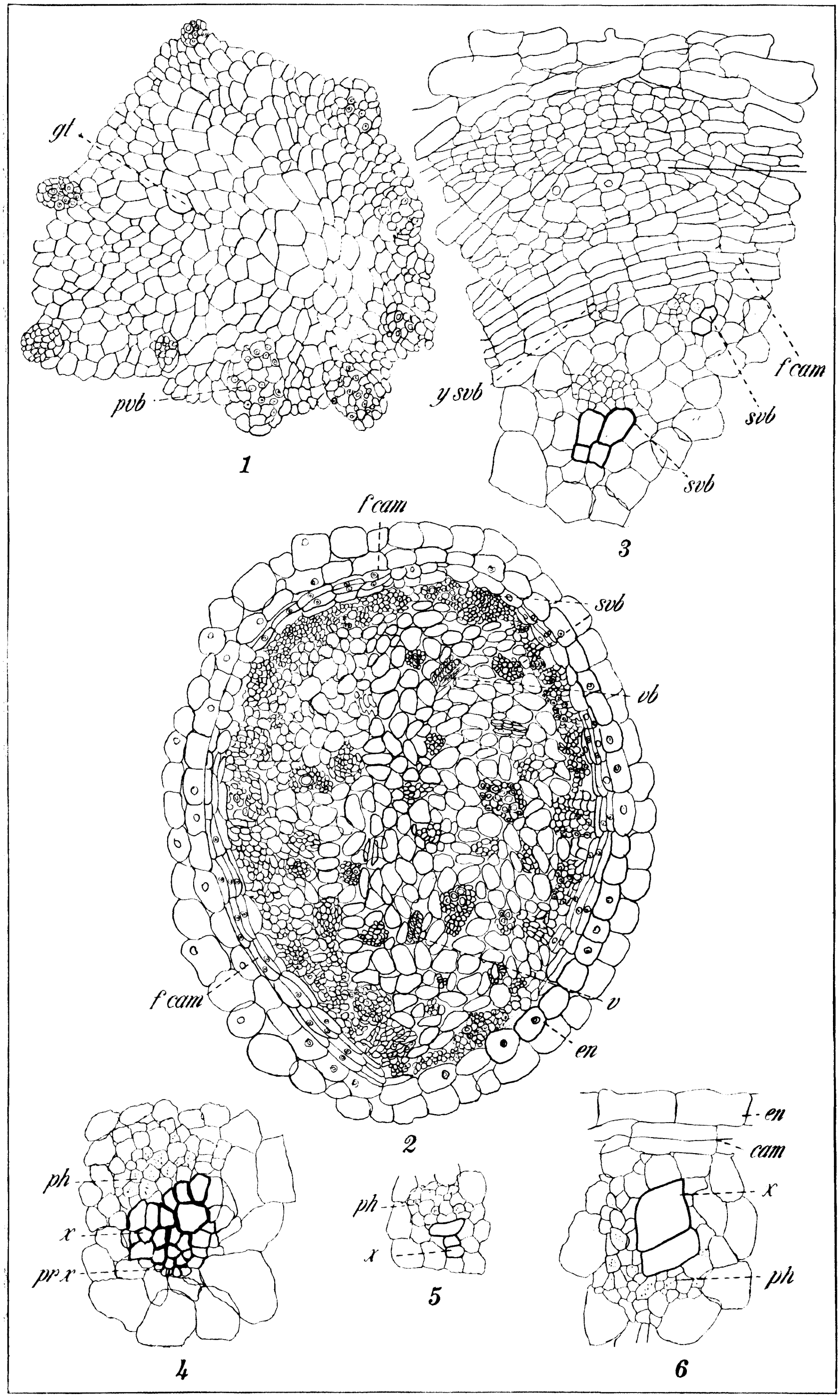
gt
pvb
1
y svb
f cam
svb
svb
3
f cam
svb
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PLATE 1.

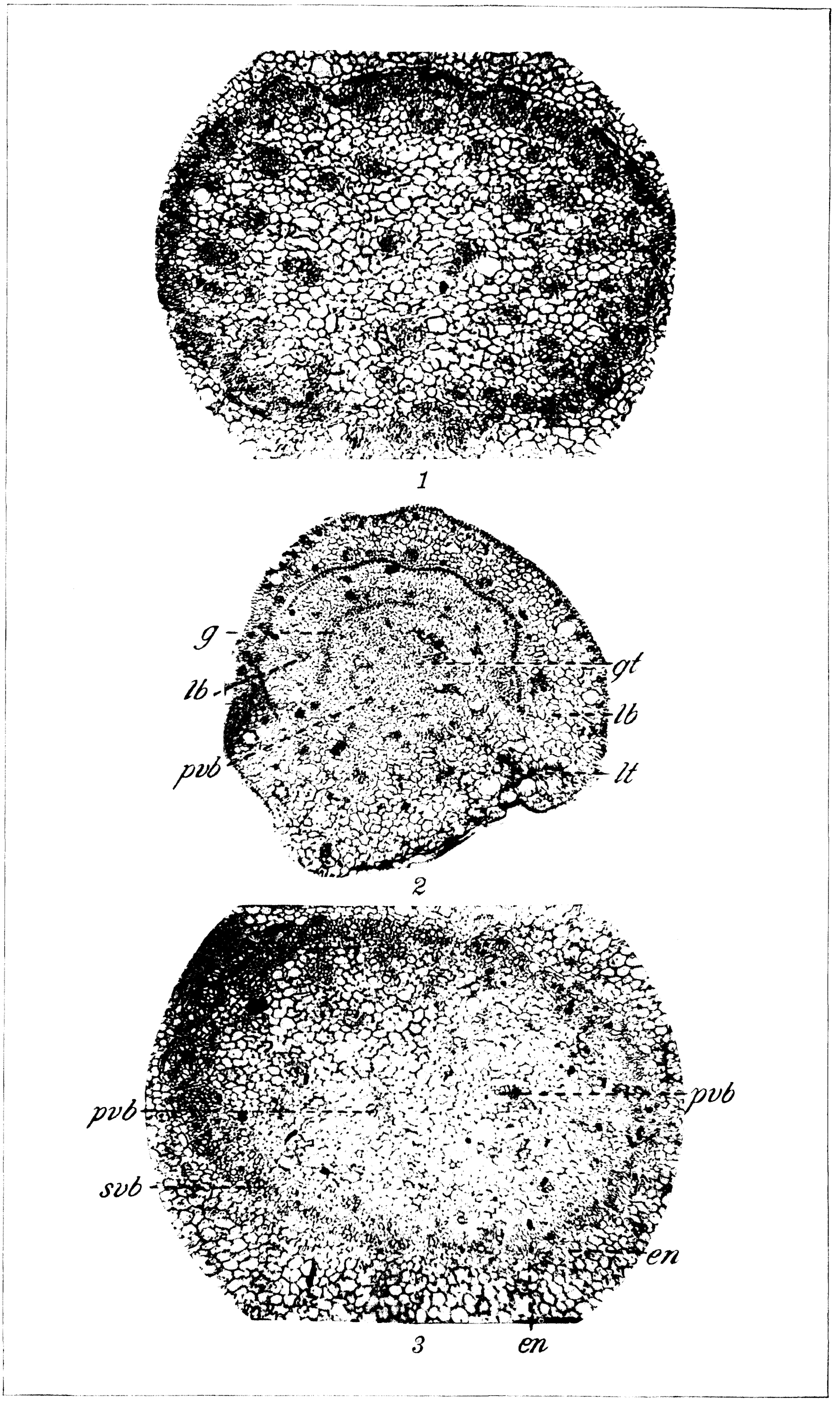

PLATE 2.

ROASTING OF PHILIPPINE LOW-GRADE CHROMITE FOR THE PRODUCTION OF SODIUM BICHROMATE [1]

By V. G. LAVA and I. OLAYAO
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FOUR TEXT FIGURES

A deposit of chrome ore, estimated to consist of at least eight million tons, is located in the Masinloc district, Zambales Province, Philippine Islands. In view of the large available quantity of this chromite, experiments were carried out by the present authors, partly in the laboratory of Consolidated Mines and partly in the Bureau of Science, to determine the best conditions for roasting the ore for the production of sodium bichromate. The results are recorded in this paper.

The production of bichromate by roasting chromite has been practiced since the early part of the 19th century,(1) when saltpeter was used for the oxidation of the ore. Around the middle of the century an improvement was made in the process by the introduction of the use of potassium carbonate, and by passing air over the mixture(8) while the latter was being heated for purposes of oxidation. Since then, many other methods have been tried, involving the following features:

(*a*) The substitution of alkali-earth compounds for the alkali carbonate used during the roasting process;
(*b*) the substitution of other cheaper alkali salts for the alkali carbonate;
(*c*) the dilution of the roasting mixture in order to effect more complete oxidation by air, by the addition of fairly inert materials;
(*d*) the decrease of the time and the increase of efficiency of roasting by improvements in mechanical features; and
(*e*) the decrease of the temperature of roasting.

A few examples may be given to illustrate these variations. In Jacquelain's process(9) the ore was roasted with lime in a reverberatory furnace at bright-red heat for 8 to 9 hours, and with ten to twelve rabblings during the roasting process. The

[1] Published with the permission of Mr. V. Elicaño, Technical Director and Vice-President, Consolidated Mines, Incorporated, Manila. Delivered at the Fifth Philippine Science Convention, February 21 to 26, 1939. Received September, 1938.

roast was decomposed with sulphuric acid to convert the insoluble calcium chromate into the soluble calcium bichromate. The solution was then heated with an emulsion of chalk to neutralize the excess acid and to precipitate the ferric salts together with the alumina and magnesia contained in the ore. After filtering, a solution of potassium carbonate was added to the filtrate to convert the calcium bichromate into potassium bichromate, and the calcium carbonate was separated by filtration. The potassium bichromate solution was then crystallized in the usual way. By this method the amount of alkali carbonate required to produce the dichromate was reduced to a minimum; or, lead chromate could be obtained without the use of the alkali salt. The great drawback of this method is that the recovery of bichromate is low.

In one of Tilghman's patents(14) potash feldspar or alkali sulphate was mixed with the ore and quicklime and the mixture roasted. In another patent potassium sulphate or potassium chloride was used in the roasting mixture together with steam in the roasting atmosphere.

In Swindell's patent(12) calcium or sodium chloride was used together with steam.

Gorman(7) roasted a mixture of ore and lime at a high temperature, then added potash, soda, or potassium sulphate and roasted again at 600° C.

In Römer's patent(10) soda was substituted for one equivalent of potash in the roasting mixture, and after sulphuric acid was added to the concentrated liquor, the potassium bichromate was precipitated, leaving the sodium sulphate in solution.

Some catalysts or diluents, such as coke and the oxides of manganese, copper, and iron were also used. Thus Wise(16) replaced a large proportion of the lime in the usual ore-lime-soda mixture by ferric oxide and magnesium oxide obtained as residue of a previous calcine. Drefahl(3) used a mixture of ore, lime, soda, and coke or charcoal in the ratio of 1 : 1.10 : 0.86 : 0.67, and blast-roasted in a sintering roaster.

Lime was also replaced by such substances as bauxite(11) or dolomite,(18) and the Russian workers,(17) working with Ural chromite of 40 per cent chromic oxide, obtained almost complete extraction with a mixture of ore, soda, and dolomite in the ratio of 1 : 0.8 : 0.8.

To prevent any loss of chromium, various patents have been taken in which the residue from the calcine which still con-

tains undecomposed ore together with the iron oxide, alumina, and magnesia, is mixed with fresh ore.(4)

Various patents have been issued for improvements in mechanical features. In Fuller's patent(5) the ore-lime-soda mixture was roasted in an automatically rabbled furnace by allowing the mixture to travel first through a zone of temperature higher than the soda fusion point and then through a zone of temperature lower than the fusion point. In Gibb's process(6) the addition of lime was altogether eliminated by roasting the ore-soda mixture in a revolving furnace at a temperature sufficient to keep the charge fluid.

Zahn and Company(19) claim certain advantages in roasting first with insufficient soda, and after leaching the calcine, roasting again with more lime and soda.

PRESENT PRACTICE IN THE MANUFACTURE OF BICHROMATE

The usual procedure in the manufacture of bichromate may be briefly described thus:(15) The ore is dried by waste furnace gases, crushed in a jaw crusher, then ground in a ball mill with a 130-mesh discharge, and stored in bins. From bins of ore as well as of the ground lime and soda ash, measured quantities of each are weighed and thoroughly mixed, first in a ball mill and finally in a Krupp mixer. The mixture is then roasted in a reverberatory furnace heated to from 800° to 1200° C. A mechanical furnace which has a revolving circular hearth of 6 meters diameter has a capacity of 2,500 kilograms and requires eight hours to roast.

The calcine is then transferred to a battery of iron tanks provided with false filter bottoms and leached with hot water, the most concentrated liquor being pumped to another tank filled with fresh calcine, until a 30° to 40° Be liquor is obtained. As calcium chromate is frequently present in the liquor, the latter is first transformed to alkali salt by addition of a measured quantity of the alkali carbonate and heating at a temperature higher than 100° C.(4) After filtration the liquor is concentrated to 50° Be, from which sodium chromate may be crystallized. Or the concentrated liquor may be treated with sulphuric acid, the sodium sulphate which crystallizes out then being removed by centrifuging or filtering by suction, and the bichromate liquor finally crystallized and dried, or dehydrated by heating in cast-iron vessels and crystallized from the molten state.

In the United States only high-grade chromite is used for roasting, probably because results of investigations show that with low-grade ores the percentage recovery based on the chromic oxide content of the ore is low. Thus Doerner's report(2) shows that low-grade ore requires more reagents to effect adequate conversion to chromate, and that less of the chromate is extracted by water leaching than with a high-grade ore—a 56 per cent chrome ore requiring 200 per cent lime and 140 per cent sodium carbonate to give a 97 per cent extraction, and a 43 per cent chrome ore requiring 200 per cent lime and 140 per cent sodium carbonate to give only 92 per cent extraction.

Our experiments show that with Philippine chromite of 33 or 37 per cent chromic oxide content only 85 to 90 per cent sodium carbonate is necessary, much less lime (10 to 25 per cent) is needed, and the water extraction can be raised to as high as 100 per cent.

EXPERIMENTAL PROCEDURE AND RESULTS

The ore used for investigation was the Masinloc ore from Zambales Province, owned by Consolidated Mines, Incorporated. Its chemical composition is given in Table 1.

TABLE 1.—*Composition of chrome ore from Masinloc, Zambales Province.*

Constituents.	Ore.	
	Crude.	Concentrated.
	Per cent.	*Per cent.*
SiO_2	5.6	1.8
Fe_2O_3	17.9	18.5
Al_2O_3 (by difference)	26.2	25.9
Cr_2O_3	33.5	37.6
MgO	16.8	16.2
CaO	trace	trace
Ti	trace	trace
V	trace	trace

This ore is closely associated with peridotite or pyroxenite intrusions, and occurs in lenticular masses of varying size apparently accumulated near the border of the peridotite intrusions. The ore mineral shows a crystalline texture usually of coarse, but sometimes of fine, grain, although massive or amorphous textures have also been observed. Conservative estimates of the tonnage of the chromite reserves in Masinloc show that there are at least 8,000,000 tons of this ore available.

In view of this abundance of the ore and of its fairly low chromic oxide content which tends to confine its usefulness to refractory purposes only, studies were made to determine whether Masinloc ore can compete with higher grade ores in the world market. The present research is a part of the above general investigation, and has for its specific object the determination of the optimum conditions for roasting Masinloc chromite for bichromate manufacture.

The ore was first ground to —150 mesh, and 2 grams mixed thoroughly with different reagents before roasting. Both platinum and porcelain crucibles were used, the latter being just as good as platinum crucibles if used not more than three or four times. The temperature of the furnace was read with a pyrometer. After a definite time of roasting the calcine in the crucible was placed in about 100 cc of water, heated to boil, and filtered, this operation being repeated three or four times. The residue was diluted with water, dilute hydrochloric acid added, and the mixture heated to make soluble whatever hexavalent chromium may have been left. Both the water extract and the acid extract were assayed for their chromate content with a standard solution of sodium thiosulphate.

Table 2 shows the results of preliminary runs with unconcentrated ore. Experiments 1 to 4 show that with no lime and with the soda-ash (93.5 per cent pure) content varying from 50 to 100 per cent, when the temperature of roasting is about 1,000° C. there is complete fusion of the mixture and a consequent low recovery. The fact that the ore was completely attacked except in experiment 4, as shown by the complete solubility in hydrochloric acid solution of the residue from the calcine, would indicate that the chromic oxide in the ore was transformed into some other compound in which the chromium was not hexavalent. When 25 per cent lime is used (experiments 5 to 8) under conditions similar to those obtaining in experiments 1 to 4, greater recovery is obtained both in the water extract and in the total extract; also, fusion is not as complete. When 75 per cent lime is used (experiments 9 to 11), still higher recoveries are obtained from mixtures of 80 per cent sodium carbonate down, but a low recovery is obtained when 100 per cent soda ash is used. This relation is greatly magnified when 125 per cent lime is used (experiments 12 to 14). A comparison of the total recoveries in experiments 1 to 4 show that while with no lime the total recovery is a linear

function of the soda ash used, this relation also obtains when 25 per cent lime is used; above 25 per cent lime total recovery is almost the same, irrespective of the soda ash used; in fact, with a quantity of soda ash above 80 per cent the total recovery is even less than with a quantity of soda ash below 80 per cent.

In all the experiments cited, 5 per cent ferric oxide was used. The effect of this substance is shown in experiments 15 to 17. It is to be noted that when both lime and soda ash are used in quantities over 100 per cent, the iron oxide has the effect of increasing both the water recovery and the total recovery.

As Table 2 showed that a total recovery of over 90 per cent could be obtained by the use of a great quantity of lime and less soda ash, an attempt was made to use this type of combination under different conditions of temperature, time of roasting, and mode of exposure. Table 3 shows effects of these factors. It is evident from this table that while between 800 and 830° C. there is no fusion of the mixture, the rate of oxidation is fairly low and the time of roasting has to be increased; on the other hand, there is no great advantage gained by a temperature much higher than 850° C., since both the water recovery and total recovery at 1000° C. are less than the corresponding recoveries at 850° C. Also, while at temperatures below 850° C. the rate of oxidation is low, at 850° C. and above the oxidation reaches its maximum between three and six hours.

From experiments 15 to 19 quenching seems to have the effect of accelerating oxidation, but, as will be shown later, produces a mechanical loss in chromate recovery. It will be observed that a sodium-carbonate content equivalent to 70 per cent of the ore gives as much total recovery as an equivalent to 80 per cent, although the water extract is slightly less in the 70 per cent soda-ash mixture.

With these mixtures containing 70 to 80 per cent soda ash in no case was the water recovery higher than 88 per cent, nor the total recovery higher than 95.5 per cent. Considering that in order to convert the water-soluble chromate into the soluble form, either further addition of soda ash to the residue from the water extraction is necessary, or carbon dioxide has to be passed through the suspension of the residue, no great advantage would be gained by the use of very much lime and a comparatively small amount of soda ash, over a small amount of lime and a slightly greater quantity of soda ash, as is shown by experiment 5 in Table 2.

TABLE 2.—*Preliminary experiments showing the effects of temperature and of varying quantities of lime, soda ash, and ferric oxide on the roasting of Masinloc chromite.*

[Samples were placed in the furnace only when the temperature was about 850°C.]

[Unconcentrated chromite, 2 grams.]

Experiment.	Time.	Lime.	Soda ash.	Ferric oxide.	Average tempera-ture.	Recovery.			Remarks.
						Water soluble.	Hydroclo-ric acid soluble.	Total.	
	Hours.	*g.*	*g.*	*g.*	°*C.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	3	0	2.0	0.1	[a] 1000	89.5	trace	89.5	Caking in all. Ore completely attacked except in experiment 4.
2	3	0	1.6	0.1	1000	73.1	trace	73.1	
3	3	0	1.4	0.1	1000	66.0	trace	66.0	
4	3	0	1.0	0.1	1000	49.0	trace	49.0	
5	4	0.5	2.0	0.1	[a] 1000	95.7	0.4	96.1	Soft caking in all. Ore completely attacked.
6	4	0.5	1.4	0.1	1000	76.5	0.8	77.3	
7	4	0.5	1.2	0.1	1000	67.7	0.4	68.1	
8	4	0.5	1.0	0.1	1000	63.4	1.3	64.7	
9	3	1.5	2.0	0.1	930	86.7	3.7	90.4	Ore completely attacked.
10	3	1.5	1.6	0.1	930	87.4	4.2	91.6	
11	3	1.5	1.2	0.1	930	77.3	5.7	83.0	
12	3	3.5	2.0	0.1	960	66.3	18.7	85.0	Fusion. Ore completely attacked.
13	3	2.5	1.6	0.1	960	86.8	7.5	94.3	
14	3	2.5	1.4	0.1	960	83.8	10.5	94.3	
15	3	2.5	1.2	0.1	960	80.5	9.0	89.5	Ore not completely attacked. Fusion.
16	3	2.5	1.0	0.1	960	77.5	9.0	86.5	
17	3	2.8	2.8	0	[a] 1000	76.2	14.1	90.3	Do.
18	3	2.8	2.8	0.2	1000	79.2	14.1	93.3	
19	3	2.8	2.8	0.4	1000	89.0	11.2	100.2	

[a] Approximate.

TABLE 3.—*Effect of the mode of exposure of large quantities of lime with varying amounts of soda ash on the roasting of Masinloc chromite.*

[Unconcentrated chromite, 2 grams.]

Experiment.	Time.	Lime.	Soda ash.	Average temperature.	Recovery.				Remarks.
					Water soluble.	Hydroclo-ric acid soluble.	Total.	Residue.	
	Hours.	*g.*	*g.*	°*C.*	*Per cent.*	*Per cent.*	*Per cent.*	*g.*	
1	2.0	2.8	1.6	1000	77.5	9.2	86.7	----------	All crucibles were placed when furnace was at 850 °C. Ore completely attacked. All mixtures fused.
2	4.0	2.8	1.6	1000	82.0	11.1	93.1	----------	
3	6.0	2.8	1.6	1000	85.3	7.5	92.8	----------	
4	*4.0*	*2.8*	*1.6*	*1000*	*81.5*	*11.9*	*93.4*	----------	
5	[a] 6.0	2.8	1.6	1000	86.2	5.2	91.4	----------	
6	3.1	2.8	1.6	1000	86.3	5.3	91.6	----------	
7	1.1	2.8	1.6	1030	82.4	6.8	89.2	----------	
8	1.1	3.6	1.6	1030	82.8	5.1	87.9	----------	
9	2.0	2.8	1.6	850	82.8	9.7	92.5	----------	
10	4.0	2.8	1.6	850	88.0	7.5	95.5	----------	In all cases there was a white yellowish layer over a green layer. Ore completely attacked. All mixtures not fused.
11	6.0	2.8	1.6	850	87.0	6.6	93.6	----------	
12	[a] 6.0	2.8	1.6	850	84.0	6.9	90.9	----------	
13	4.0	2.8	1.4	850	84.7	8.7	93.4	----------	
14	3.8	2.8	1.4	860	86.0	7.4	93.4	----------	
15	2.0	2.8	1.6	800	38.7	16.8	55.5	0.52	Two layers not distinct. Ore not completely attacked. All mixtures not fused.
16	4.0	2.8	1.6	810	41.0	20.8	61.8	0.37	
17	[b] 6.0	2.8	1.6	830	53.9	7.9	61.8	0.06	
18	4.0	2.8	1.4	810	45.0	15.3	60.3	0.39	
19	[b] 6.0	2.8	1.4	830	62.0	9.5	71.5	0.07	

[a] Left overnight in furnace.

[b] Quenched once after 4 hours.

Accordingly attention was focused on the possibilities of using only a little lime and amounts of soda ash greater than 80 per cent of the ore—a plotting of the soda-ash-water recovery curve from experiments in Table 2 indicating that over 95 per cent water extraction is possible with 90 to 95 per cent soda ash. In previous experiments the difficulty appeared to be due to a deficiency in oxidation as a result of the fusion of the mixture. If this be so, the difficulty can be overcome by a comparatively low temperature exposure and by the addition of substances that would create a porous structure in the roasted mixture. Accordingly several substances, like sawdust, bagasse, iron oxide, and rice hulls were tried.

Table 4 shows the effect of the addition of these substances to roasting mixtures of varying lime and soda ash contents. Experiments 3, 6, and 19 show that in a mixture of 25 per cent lime and 95 per cent soda ash the addition of 50 per cent rice hull, ground to −60 mesh, will produce a water extraction of 97 per cent or over, while without rice hulls an extraction of only 90 per cent is possible (Experiment 1). If lime is completely eliminated, however, water extraction gives only 90 per cent recovery as shown by Experiment 12 (Table 4). The addition of 30 per cent or even 15 per cent instead of 50 per cent rice hulls has possibilities, as is shown by Experiments 20 and 21. Sawdust and bagasse, ground to −60 mesh, also seem to be very effective, as Experiments 22, 25, and 30 show; coked rice hull, bagasse coke, and bagasse ash, however, are not effective, as shown by Experiments 10, 17, and 18.

The use of 15 per cent lime is evidently sufficient. With this amount no carbonaceous agent is necessary to give a 100 per cent water recovery (Experiment 39) while amounts of iron oxide from 10 to 20 per cent or 25 to 75 per cent sawdust do not lower the recovery (Experiments 32 to 38). It is thus clear that while carbonaceous agents play an important rôle in the roasting of chromite, the most important factor is the lime concentration of the roasting mixture.

In these experiments and in others to follow optimum conditions of recovery are always associated with calcines which are porous and greenish.

The case of roasting the concentrated ore is only slightlv different. Tables 5 and 6 show the recovery of chromium as chromate under different conditions of soda-ash content, liming, and diluting agents. Experiments 1, 7, and 15 (Table 5)

TABLE 4.—*Effect on the roasting of Masinloc chromite of small quantities of lime with varying quantities of soda ash and other substances.*

[Unconcentrated chromite, 2 grams.]

[Samples placed in furnace when cold.]

Experiment.	Time.	Lime.	Soda ash.	Other reagents.	Average temperature.	Recovery.			Residue.	Remarks.
						Water soluble.	Hydrochloric acid.	Total.		
	Hours.	*g.*	*g.*	*g.*	°*C.*	*Per cent.*	*Per cent.*	*Per cent.*	*g.*	
1	4	0.5	1.9	None	930	90.2	1.5	91.7	0.12	
2	4	0.5	1.0	Rice husk	930	63.0	1.2	64.2	0.62	Not completely fused.
3	4	0.5	1.9	1.0 ground ipa (—60m)	930	97.5	0.2	97.7	0.11	All quenched 2 hours before completion.
4	4	1.5	1.9	None	930	43.6	21.6	65.2	0.42	
5	4	1.5	1.0	do	930	63.4	9.7	73.1	0.20	
6	4	0.5	1.9	1.0 ground ipa (—60m)	930	97.0	0.3	97.3	0.16	
7	4	0.5	1.5	do	930	81.1	0.4	81.5	0.56	
8	4	0.5	1.0	do	930	52.3	0.7	53.0	1.11	Melted on sides of platinum.
9	4	0.5	0.5	do	930	31.2	2.3	33.5	1.33	Quenched 2 hours before completion.
10	4	0.5	1.9	1.0 coked ipa (—60m)	930	68.8	11.6	80.4	0.58	
11	4	0.5	1.9	0.5 ground ipa (—60m)	930	93.5	0.6	94.4	0.20	
12	3.8	0	1.9	1.0 ipa (—60m)	860	90.0	0.2	90.2		
13	3.8	0	1.5	do	860	67.8	0.2	68.0		
14	3.8	0.5	1.5	do	860	79.8	0.1	79.9		No fusion except in experiment 16.
15	3.8	1.0	1.5	do	860	52.3	15.5	67.8		Quenched 2 hours before completion.
16	3.8	1.5	1.5	do	860	40.3	33.3	73.6		
17	3.8	0.5	1.9	1.0 bagasse coke	860	91.0	0.2	91.2		
18	3.8	0.5	1.9	1.0 bagasse ash	860	63.2	0.1	63.3		
19	3.8	0.5	1.9	1.0 ground ipa (—60m)	870	98.0	trace	98.0		Hard cake.
20	3.8	0.5	1.9	0.6 ipa (—60m)	870	100.0	trace	100.0		Less hard cake. Not quenched at all.
21	3.8	0.5	1.9	0.3 ipa (—60m)	870	100.0	trace	100.0	only SiO_2	Soft, and porous cake.
22	3.8	0.5	1.9	1.0 sawdust (—60m)	870	97.0	1.4	98.4		Do.
23	3.8	0.5	1.9	0.3 sawdust (—60m)	870	96.6	1.5	98.1		Do.
24	3.8	0.5	1.9	1.0 bagasse (—60m)	880	100.0	trace	100.0		Do.

25	3.8	0.5	1.9	1.0 sawdust (—60m)	870	98.5	1.8	100.3		Dark green, porous.
26	3.8	0.5	1.5	2.0 sawdust (—60m)	870	85.8	1.7	87.5		Brown, porous.
27	3.8	0.5	1.5	1.5 sawdust (—60m)	870	87.5	1.4	88.9		Do.
28	3.8	0.5	1.5	1.0 sawdust (—60m)	870	87.5	0.8	88.3		Do.
29	3.8	0.5	1.5	2.0 sawdust (—60m)	870	60.2	1.4	61.6		Do.
30	3.8	0.3	1.9	1.0 sawdust (—60m)	870	100.0	trace	100.0		Dark green, porous.
31	3.8	0.3	1.7	do	870	91.2	0.1	91.3		Do.
32	4.0	0.7	1.8	do	880	79.0	7.9	86.9		Not so porous, yellow scum on top.
33	4.0	0.3	1.9	0.2 ferric oxide	880	100.0	trace	100.0		Porous, greenish brown.
34	4.0	0.3	1.9	0.4 ferric oxide	880	100.0	trace	100.0		Do.
35	4.0	0.3	1.8	1.0 sawdust (—60m)	880	100.0	trace	100.0		Do.
36	4.0	0.3	1.9	1.5 sawdust (—60m)	880	100.0	trace	100.0		Very porous, greenish brown.
37	4.0	0.3	1.9	1.0 sawdust (—60m)	880	100.0	trace	100.0		Porous, greenish brown.
38	4.0	0.3	1.9	0.5 sawdust (—60m)	880	100.0	trace	100.0		Do.
39	4.0	0.3	1.9	None	880	100.0	trace	100.0		Do.

TABLE 5.—*Effect on the roasting of concentrated Masinloc chromite of small quantities of lime, with varying quantities of soda ash and other reagents.*

[Concentrated chromite, 2 grams.]

[Exposure, 3.8 hours.]

Experiment.	Lime.	Soda ash.	Other reagents.	Averag tempera-ture.	Recovery. Water soluble.	Recovery. Hydro-chloric acid soluble.	Recovery. Total.	Remarks.
	g.	*g.*	*g.*	°C.	*Per cent.*	*Per cent.*	*Per cent.*	
1	0.5	1.9	1.0 ipa (—20m)	880	93.2	0.2	93.4	Porous, dark green.
2	0.5	1.9	0.2 ipa (—20m)	880	51.3	5.8	57.1	Fused, yellow.
3	0.5	1.9	do	880	72.4	0.8	73.2	Do.
4	0.5	1.9	1.0 sawdust (—60m)	880	93.4	2.7	96.1	Porous, dark brown.
5	0.5	1.9	0.2 sawdust (—60m)	880	56.5	2.0	58.5	Fused, yellow.
6	0.5	2.1	1.0 ipa (—20m)	870	93.4	0.5	93.9	Porous, dark brown.
7	0.5	1.9	do	870	93.2	0.5	93.7	Do.
8	0.5	1.5	do	870	81.0	0.5	81.5	Porous, brown.
9	0.5	2.1	0.5 ipa (—20m)	870	72.6	2.8	75.4	Fused, yellow.
10	0.5	2.1	0.5 bagasse (—60m)	870	54.1	13.2	67.3	Do.
11	0.5	2.1	1.0 sawdust (—60m)	870	94.0	3.7	97.7	Do.
12	0.5	2.1	0.5 sawdust (—60m)	870	61.6	0.9	62.5	Do.
13	[a] 1.0	2.1	1.0 ipa (—20m)	870	45.2	0.6	45.8	Do.
14	0.5	1.9	1.5 sawdust (—60m)	870	93.2	3.4	96.6	Porous, dark brown.
15	0.5	1.9	1.0 sawdust (—60m)	870	95.2	2.2	97.4	Do.
16	0.5	1.9	0.5 sawdust (—60m)	870	85.8	3.5	89.3	Fused, yellow.
17	0.5	2.5	1.0 sawdust (—60m)	880	91.0	0.8	91.8	Do.
18	0.5	1.9	do	880	90.0	2.2	92.2	Do.
19	0.3	1.9	do	880	97.0	3.0	100.0	Porous, greenish.
20	1.0	2.5	do	880	75.5	4.6	80.1	Fused, greenish.
21	1.0	2.0	do	880	70.1	6.1	76.2	Do.
22	1.0	1.5	do	880	70.5	9.8	80.3	Do.

23	0.3	1.9	do	870	91.0	trace	91.0	Porous, dark green	[c]
24	0.3	1.7	do	870	87.0	0.9	87.9	Porous, brown.	
25	0.3	0.5	1.0 sawdust (—60m)+1.0 sodium sulphate	870	25.8	0.3	26.1	Porous, dark green.	
26	0.3	1.0	do	870	9.3	2.2	11.5	Porous, yellow.	
27	0	1.9	1.0 sawdust (—60m) +1.0 Sienna [b]	870	83.5	trace	83.5	Porous, brown.	
28	0	1.7	do	870	75.8	trace	75.8	Do.	

[a] $CaCO_3$. [b] Laboratory Sienna. [c] There was very little airing.

TABLE 3.—*Effect on the roasting of concentrated Masinloc chromite of varying lime and soda ash, other conditions remaining constant.*

[Concentrated chromite, 2 grams.]

Experiment.	Time.	Lime.	Soda ash.	Sawdust (—60m).	Average temperature.	Recovery. Water soluble.	Recovery. Hydrochloric acid soluble.	Recovery. Total.	Remarks.
	Hours.	*g.*	*g.*	*g.*	°*C.*	*Per cent.*	*Per cent.*	*Per cent.*	
1	3.8	2.5	1.0	0.5	890	76.3	6.5	81.8	Fused, brown-yellow.
2	3.8	1.5	1.0	0.5	890	66.6	9.2	75.8	Fused, yellow.
3	3.8	0.5	1.0	0.5	890	48.4	10.3	58.7	Do.
4	3.8	0.3	1.0	0.5	890	52.6	3.8	56.4	Porous, dark brown.
5	3.8	0	1.0	0.5	890	44.7	trace	44.7	Do.
6	3.8	2.5	1.5	0.5	890	78.4	13.0	91.4	Fused, yellow.
7	3.8	1.5	1.5	0.5	890	60.7	18.7	79.4	Do.
8	3.8	0.5	1.5	0.5	890	61.5	10.3	71.8	Do.
9	3.8	0.3	1.5	0.5	890	74.4	4.2	78.6	Porous, brown.
10	3.8	0	1.5	0.5	890	66.4	trace	66.4	Do.
11	3.8	2.5	1.9	0.5	890	55.7	24.2	79.9	Porous, yellow.
12	3.8	1.5	1.9	0.5	890	66.5	21.0	87.9	Fused, yellow.
13	3.8	0.5	1.9	0.5	890	66.1	11.7	77.8	Do.
14	3.8	0.3	1.9	0.5	890	87.8	1.8	89.6	Porous, yellow.
15	3.8	0	1.9	0.5	890	80.7	trace	80.7	Porous, brown.
16	4.0	0.5	1.9	0.5	880	79.5	2.4	81.9	Fused, yellow.
17	4.0	0.4	1.9	0.5	880	76.0	4.0	80.0	Do.
18	4.0	0.3	1.9	0.5	880	88.5	5.9	94.4	Do.
19	4.0	0.2	1.9	0.5	880	95.9	1.7	97.6	Porous, dark brown.
20	4.0	0.1	1.9	0.5	880	93.0	trace	93.0	Do.
21	4.0	0	1.9	0.5	880	88.8	trace	88.8	Do.
22	4.0	0.3	1.9	1.0	880	93.5	2.1	95.6	Do.
23	4.0	0.3	1.9	1.5	880	95.0	0.6	95.6	Do.

24	4.0	0.3	1.9	0	880	72.3	2.7	75.0	Fused, yellow.
25	4.0	3.25	1.9	0.5	880	80.6	10.5	91.1	Porous, greenish yellow.
26	4.0	1.5	1.5	0.5	880	62.5	15.0	77.5	Fused, yellow.
27	4.0	0.5	1.5	0.5	880	66.0	3.9	69.9	Do.
28	4.0	0.3	1.5	0.5	880	72.3	8.2	80.5	Porous, dark brown.
29	4.0	0.15	1.5	0.5	880	76.8	0.6	77.4	Do.
30	4.0	0	1.5	0.5	880	72.0	trace	72.0	Porous, brown.
31	4.0	0.3	1.5	1.5	880	80.6	0.9	81.5	Porous, dark brown.
32	4.0	0.2	2.0	1.0	880	94.5	2.5	97.0	Porous, greenish.
33	4.0	0.2	1.9	1.0	880	97.3	0.9	98.2	Do.
34	4.0	0.2	1.8	1.0	880	96.7	1.1	97.8	Do.
35	4.0	0.2	1.7	1.0	880	91.3	0.9	92.2	Do.
36	4.0	0.2	1.9	0.5	880	93.5	3.5	97.0	Not so porous, greenish.
37	4.0	0.2	1.9	0	880	81.0	9.3	90.3	Least porous, greenish.
38	4.0	0.2	1.9	1.5	880	95.9	1.3	97.2	Very porous, greenish.
39	4.0	0.2	1.9	0.2	880	93.0	0.9	93.9	Not so porous, greenish brown.

show that with 25 per cent lime and 95 per cent soda ash, 93 per cent water recovery may be obtained with 50 per cent of ground rice hulls (—20 mesh); and 93 to 95 per cent recovery when 50 per cent sawdust is used (Experiments 4 and 15). No advantage is obtained by the use of 105 to 125 per cent of soda ash with the same amount of lime and rice hulls or sawdust (Experiments 6 and 17). Calcium carbonate apparently cannot take the place of lime (Experiment 13), and the addition of sodium sulphate to the roast mixture does not give good recovery (Experiments 25 and 26). "Sienna" prepared from the residue of a completely roasted ore seems to offer no advantage, probably due to the fact that no lime was added to the roasting mixture (Experiments 27 and 28). From Table 6 it appears that the best lime content is around 10 per cent (Experiment 19), and that more than 25 per cent sawdust is necessary for complete recovery of chromium (Experiment 23). This finding is verified by Experiments 33 and 38, where 50 per cent sawdust gives 97 per cent water recovery and 75 per cent sawdust gives 96 per cent recovery. It would also appear from experiment 34 that 90 per cent soda ash is sufficient for a 97 per cent extraction.

Before combining all the optimum conditions for the highest recovery of chromate, there still remains the study of the relative values of different reagents for diluting or other purposes. The substances tested were sawdust (—60 mesh), rice hulls (—20 mesh), bagasse (—60 mesh), flour, and iron oxide. Table 7 shows the effect of different quantities of these reagents on the recovery of chromate from roasting mixtures of concentrated chromite under optimum conditions of lime and soda ash. In these experiments the air supply was decreased. Rice hulls appear to be the best catalytic agent and give optimum recovery when used at 15 per cent. Sawdust and flour behave almost identically, yielding optimum recovery when used at about 50 per cent. Bagasse and iron oxides are the least effective diluting reagents, optimum recovery being obtained at 5 to 15 per cent concentration of these reagents.

We are now ready to determine water soluble recoveries with the optimum conditions of temperature 890° C., with sawdust clinkering agent constant, and with varying conditions of lime and soda ash. Table 8 gives the recoveries from unconcentrated ore and Table 9 gives those from concentrated ore. Text figs.

TABLE 7.—*Effect of catalytic agents on the roasting of concentrated Masinloc chromite, other conditions remaining constant.*

[Concentrated chromite, 2 grams; lime, 0.2 grams; soda ash, 1.9 grams.]

[Exposed 4 hours. Average temperature, 880°C.]

Experiment.	Other reagents.	Recovery water soluble.	Remarks.
	g.	*Per cent.*	
1	None.	85.8	Fused, dark green with yellow.
2	0.5 sawdust (—60m)	91.8	Not very porous, dark brown.
3	1.0 sawdust (—60m)	93.6	Porous, dark brown.
4	1.5 sawdust (—60m)	94.0	Do.
5	2.0 sawdust (—60m)	93.5	Do.
6	0.1 rice hulls (—20m)	92.6	Do.
7	0.3 rice hulls (—20m)	96.0	Do.
8	0.5 rice hulls (—20m)	93.5	Do.
9	1.0 rice hulls (—20m)	91.0	Porous, brown.
10	1.5 rice hulls (—20m)	87.0	Do.
11	2.0 rice hulls (—20m)	81.0	Do.
12	0.3 bagasse (—60m)	92.2	Slight fusion on bottom, brown.
13	0.5 bagasse (—60m)	91.3	Do.
14	1.0 bagasse (—60m)	90.9	Do.
15	1.5 bagasse (—60m)	91.3	Very porous, brown.
16	0.5 flour	91.0	Not very porous, dark brown.
17	1.0 flour	95.0	Slightly fused, dark brown.
18	1.5 flour	93.5	Porous, dark brown.
19	2.0 flour	91.5	Do.
20	0.1 ferric oxide	92.7	Slightly porous, dark brown.
21	0.2 ferric oxide	91.9	Porous, dark brown.
22	0.8 ferric oxide	89.6	Porous, brown.
23	1.5 ferric oxide	85.5	Do.

1 and 2 show the relation between water recovery and lime concentration for unconcentrated and concentrated ores respectively, and text figs. 3 and 4 show the relation between water recovery and soda ash concentration for the same samples.

From tables 8 and 9 and from text figs. 3 and 4 the poor results obtained in our preliminary experiments (Table 2) on the effect of varying soda ash in the fusion mixture can readily be understood. While the curves for both unconcentrated and concentrated ores are similar in character, a similarity which indicates that the ore actually possesses these characteristics, the curves for the different lime contents vary so greatly that at first glance they give the impression of error in manipulation or determination.

The case is different when the effect of varying lime content is studied (text figs. 1 and 2). Here the curves for different soda ash contents are similar in character, and they all point to the same maximum point of water recovery—0.45 to 0.50

TABLE 8.—*Effect of lime on the roasting of unconcentrated Masinloc chromite at different concentrations of soda ash and at the optimum concentration of sawdust.*

[Unconcentrated chromite, 2 grams; sawdust (— 60 m), 1 gram.]

[Exposure, 4 hours.]

Experiment.	Lime.	Soda ash.	Average temperature.	Recovery water soluble.	Remarks.
	g.	*g.*	°*C.*	*Per cent.*	
1	0	1.9	890	94.6	Porous, brownish green.
2	0.1	1.9	890	98.8	Do.
3	0.2	1.9	890	100.0	Do.
4	0.3	1.9	890	100.0	Do.
5	0.4	1.9	890	100.0	Porous, green.
6	0.5	1.9	890	100.0	Do.
7	0.7	1.9	890	81.1	Fused, yellow top.
8	1.0	1.9	890	79.8	Do.
9	1.5	1.9	890	72.2	Do.
10	2.5	1.9	890	53.7	Do.
11	3.5	1.9	890	59.0	Porous, yellow top.
12	0	1.8	890	91.4	Porous, brownish green.
13	0.2	1.8	890	98.0	Do.
14	0.4	1.8	890	100.0	Do.
15	0.5	1.8	890	100.0	Do.
16	0.7	1.8	890	91.8	Do.
17	1.0	1.8	890	77.0	Fused, yellow top.
18	1.5	1.8	890	72.6	Do.
19	2.5	1.8	890	62.0	Porous, yellow top.
20	3.5	1.8	890	66.5	Do.
21	0.45	1.7	890	96.5	Porous, brownish green.
22	0	1.6	900	80.8	Porous, brown.
23	0.1	1.6	900	81.1	Do.
24	0.2	1.6	900	86.8	Porous, brownish green.
25	0.3	1.6	900	90.0	Do.
26	0.4	1.6	900	90.8	Do.
27	0.5	1.6	900	91.1	Do.
28	0.7	1.6	900	85.5	Porous, yellow dots.
29	1.0	1.6	900	59.6	Fused, yellow top.
30	1.5	1.6	900	59.6	Do.
31	2.5	1.6	900	73.5	Porous, yellow top.
32	3.5	1.6	900	72.0	Do.
33	0	1.0	900	47.8	Porous, brownish green.
34	0.2	1.0	900	49.6	Do.
35	0.5	1.0	900	58.9	Porous, yellow dots.
36	0.7	1.0	900	65.0	Do.
37	1.0	1.0	900	73.0	Do.
38	2.0	1.0	900	70.6	Fused, yellow top.
39	3.5	1.0	900	69.2	Porous, yellow dots.
40	0	0.5	900	30.0	Porous, brownish green.
41	0.2	0.5	900	28.5	Do.
42	0.5	0.5	900	37.3	Porous, green.
43	1.0	0.5	900	40.6	Do.
44	3.5	0.5	900	42.7	Porous, green, white dots.
45	4.0	2.8	900	53.5	Fused, yellow.

TABLE 9.—*Effect of lime on the roasting of concentrated Masinloc chromite at different concentrations of soda ash and at the optimum concentration of sawdust.*

[Concentrated chromite, 2 grams; sawdust (— 60 m), 1 gram.]

[Average temperature, 890°C.; exposure, 4 hours.]

Experiment.	Lime.	Soda ash.	Recovery, water soluble.	Remarks.
	g.	*g.*	*Per cent.*	
1	0	1.9	78.4	Porous, brown with yellow dots.
2	0.1	1.9	95.8	Porous, dark green.
3	0.2	1.9	98.7	Do.
4	0.3	1.9	94.4	Fairly porous, dark green.
5	0.4	1.9	82.0	Fused, yellow top.
6	0.5	1.9	77.9	Do.
7	0.7	1.9	81.3	Do.
8	1.0	1.9	80.2	Do.
9	1.5	1.9	71.4	Do.
10	2.5	1.9	73.4	Slightly porous, yellow top.
11	3.5	1.9	75.9	Do.
12	0	1.8	81.8	Porous, brown.
13	0.1	1.8	89.5	Do.
14	0.2	1.8	98.7	Porous, dark green.
15	0.3	1.8	86.1	Fused, yellow top.
16	0.4	1.8	68.5	Do.
17	0.5	1.8	76.6	Do.
18	0.7	1.8	82.1	Do.
19	1.0	1.8	71.8	Do.
20	1.5	1.8	78.0	Do.
21	2.5	1.8	86.7	Porous, brownish green.
22	3.5	1.8	86.7	Do.
23	0	1.6	76.8	Do.
24	0.1	1.6	90.5	Do.
25	0.2	1.6	90.5	Do.
26	0.3	1.6	88.6	Do.
27	0.4	1.6	70.0	Fused, yellow dots.
28	0.5	1.6	71.7	Do.
29	0.7	1.6	64.0	Do.
30	1.0	1.6	67.1	Do.
31	1.5	1.6	68.1	Do.
32	2.5	1.6	81.5	Porous, yellow dots.
33	3.5	1.6	84.2	Porous, brownish yellow.
34	0	1.0	47.5	Do.
35	0.2	1.0	55.4	Do.
36	0.5	1.0	59.3	Do.
37	0.7	1.0	66.8	Do.
38	1.0	1.0	70.0	Slightly fused, yellow top.
39	2.0	1.0	76.7	Porous, yellow top.
40	3.5	1.0	77.5	Porous, dark green.
41	0	0.5	34.0	Porous, brownish green
42	0.2	0.5	31.8	Do.
43	0.5	0.5	36.2	Do.
44	1.0	0.5	50.0	Do.
45	3.5	0.5	52.6	Do.

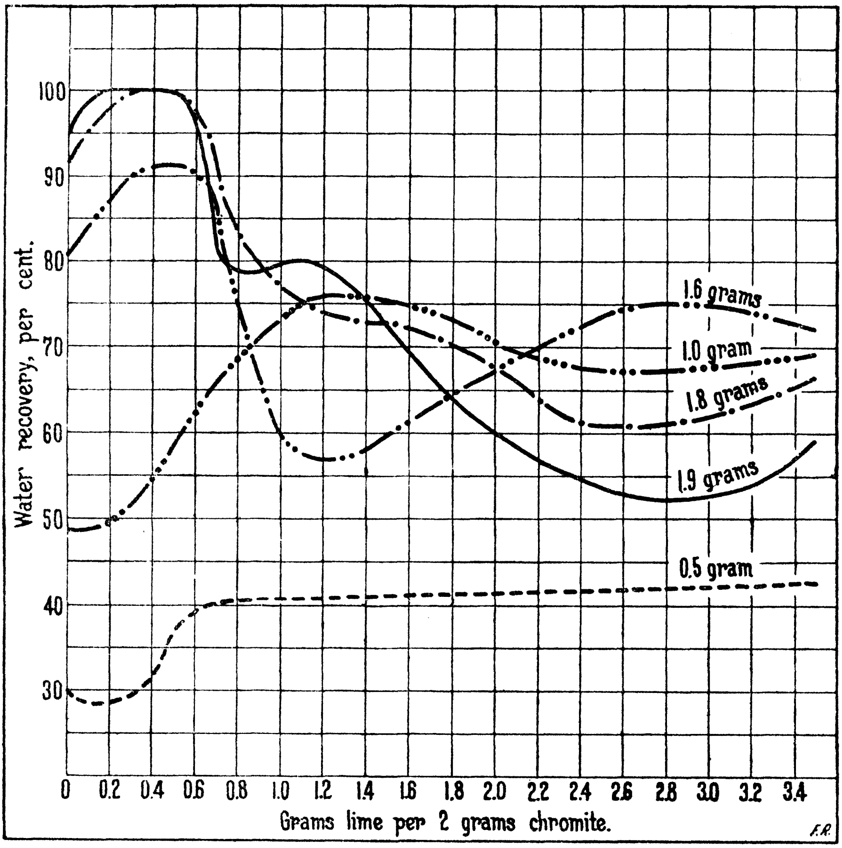

FIG. 1. Relation between quantity of lime used and water recovery from unconcentrated chromite with varying amounts of soda ash.

gram of lime per 2 grams of ore for the unconcentrated ore, and 0.15 to 0.20 gram of lime per 2 grams of ore for the concentrated ore, this maximum recovery being obtained only for mixtures containing more than 50 per cent soda ash, and minimum recovery for mixtures of 25 per cent soda ash or below. At no point up to 175 per cent lime is maximum recovery to be obtained except at the point already mentioned, and the failure of some workers to obtain a 100 per cent recovery by combining a great quantity of lime even with a great quantity of soda ash is now easy to understand.

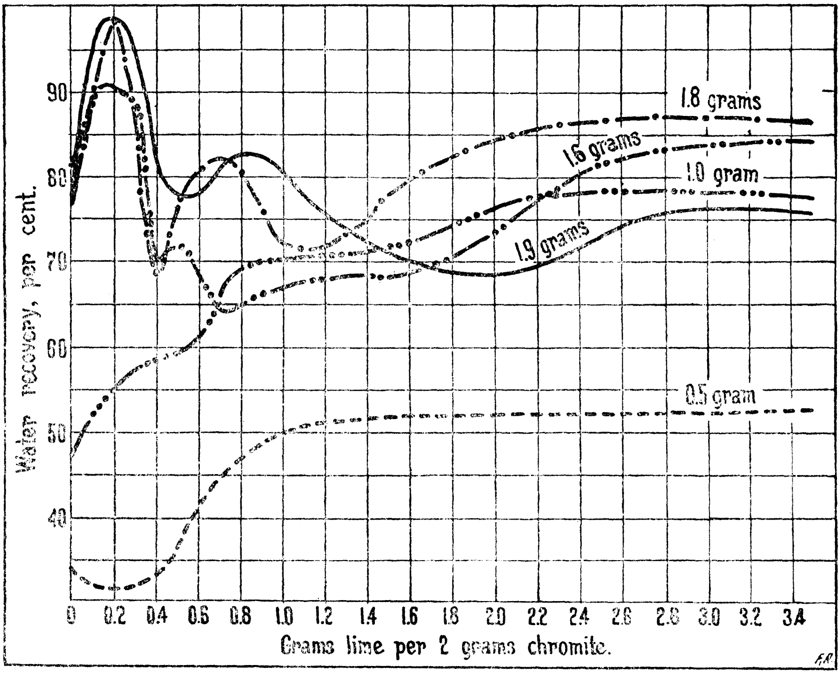

FIG. 2. Relation between quantity of lime used and water recovery from concentrated chromite with varying amounts of soda ash.

Moreover, among the chemical constituents of both unconcentrated and concentrated ores there is no ratio of the percentages of any constituent in the two samples that approximates 2 or 3, the ratio of the optimum limings for the unconcentrated over the concentrated sample, except that for silica. Or, to put it in another way, the ratios of the lime requirements to the silica contents are 4.5 for the unconcentrated ore and 5.5 for the concentrated ore, indicating that the effect of optimum liming is to take care of the silica of the ore, deficiency of liming resulting in part of the ore not being attacked, and excess in liming giving rise to complex calcium compounds of chromium which are not easily convertible into chromate. This finding is in agreement with Doerner's finding, in his experiments on the roasting of chromic oxide with sodium sulphate and lime, that silica is most detrimental to purity.

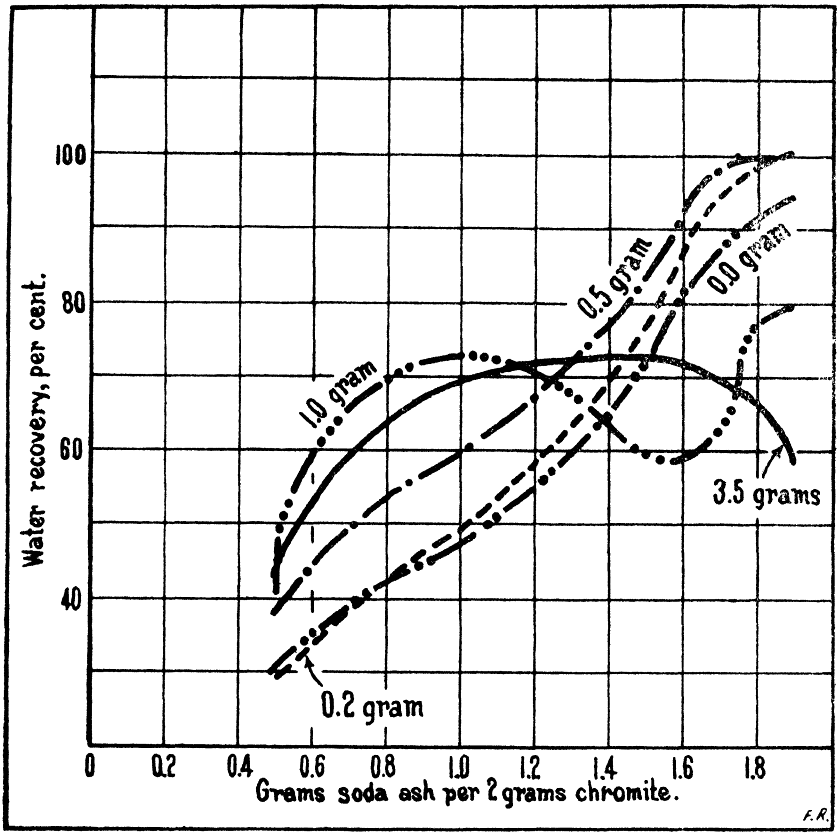

FIG. 8. Relation between quantity of soda ash used and water recovery from unconcentrated chromite with varying amounts of lime.

SUMMARY

For the efficient roasting of Masinloc chromite it has been shown that the percentages of lime, soda ash, and carbonaceous and diluting reagents are very important items to be considered. The optimum temperature of roasting is between 800 and 900° C. Of the carbonaceous substances, sawdust used at 50 per cent of the weight of chromite, or rice hulls used at 15 per cent of the weight of chromite, help to give the highest recovery of chromium as chromate. The optimum amount of soda ash (93.5 per cent purity) required for the highest recovery is between 85 and 90 per cent of the weight of the chromite, while the optimum amount of lime required is between 22 and 25 per cent for the unconcentrated chromite and around 10 per cent for the chromite concentrate. It is suggested that the

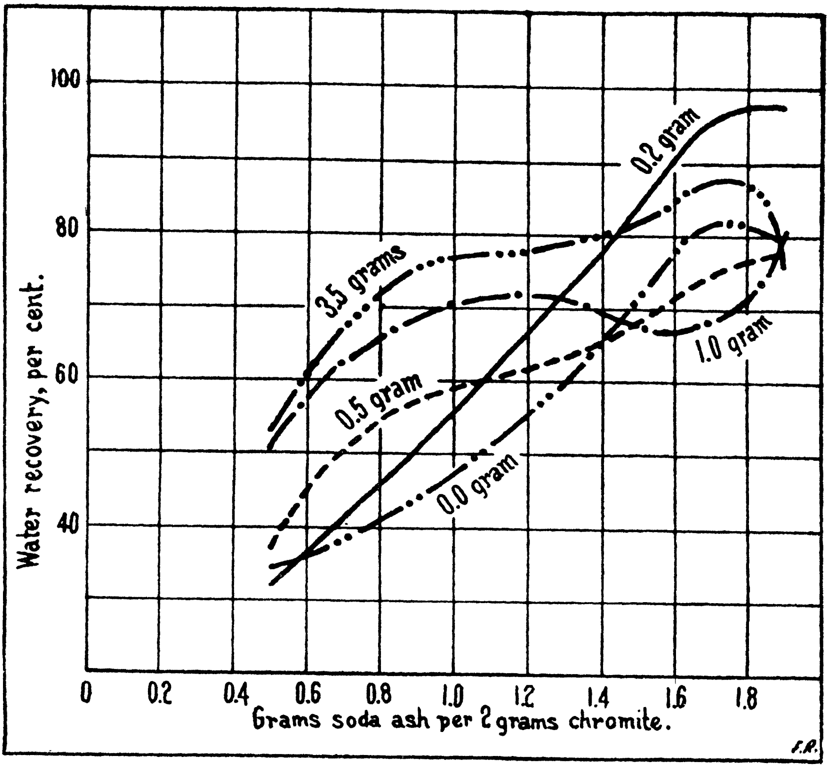

FIG. 4. Relation between the quantity of soda ash used and water recovery from concentrated chromite with varying amounts of lime.

exact lime requirements have something to do with the amount of silica in the chromite, about 5 times as much lime being required as there is silicia. A theoretical study of the effects of lime on the chromite constituents, together with an inquiry into the nature of chemical interaction among the chromite, soda ash, and lime on the one hand, and the catalytic carbonaceous or diluting agents on the other, would be highly interesting and fruitful.

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ILLUSTRATIONS

TEXT FIGURES

THE ILOKO ADJECTIVAL VOICE

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INTRODUCTION

I. VOICES IN ILOKO

There are two voices in Iloko, the substantival voice and the adjectival voice.

These two voices have been called, although very improperly, "active" and "passive." We have taken the liberty to give them new names, as has been explained before.[1]

Each of these two voices has its own special prefixes, infixes, and suffixes.

The Iloko have a propensity to a verbal construction, called "passive" by most grammarians, which we call substantival. Instead of saying: "I do this," they will say: "This is my doing." This construction, however, is far from general, and it is necessary to know when this substantival construction has to be used, and when the regular active construction, which we call adjectival, is required.

We shall first say a word about these two constructions in themselves, so as to explain them as clearly as possible, and then something about their use.

I. 1. The adjectival construction or voice is formed by putting the Iloko term which represents the English subject (and which we shall call the subject in the course of this grammar), in the nominative, and the Iloko term which represents the English object (and which we shall call the object in the course of this grammar), if there is any, in the oblique.

2. The substantival construction or voice is formed by putting the Iloko term that represents the English subject, or the subject, in the genitive, and the Iloko term that translates the English object, or the object, in the nominative. For instance:

1. In the sentence: "I take rice," "I" is the subject, and "rice" is the object. The construction of this sentence will be adjec-

[1] Iloko Substantives and Adjectives. App. Anthropos 26 (1931) 486–488.

tival in Iloko, and thus "I" will be in the nominative, and "rice" will be in the oblique.

Thus, in *Mañgálaak ití bagás, ak* is the abbreviated form of the personal pronoun in the nominative, and *ití bagás,* as may be seen by the article, is in the oblique.

2. In the sentence: "I take the rice," "I" is the subject, and "the rice" is the object. The construction of this sentence will be substantival in Iloko, and thus, "I" will be in the genitive and "the rice" will be in the nominative.

Thus in *Aláek ti bagás, k* (for *ko*) is the possessive pronoun, which, of course, represents the genitive, and *ti bagás,* as may be seen by the article, is in the nominative.

3. *a.* The place of each member of the sentence is the same in both voices: First, the verb; then, the subject; and finally, the object, thus: *mañgálaak ití bagás,* and *aláek ti bagás.*

NOTE 1. It may happen that the subject of the substantival voice is not a possessive, while its object is a personal pronoun; in this case the subject has to follow the verb immediately in the shape of a possessive of the 3d person, and the complete subject has to be repeated after the object.[2] Examples.

The boy laughs at me: *katawáannak ti ubíñg.*
The old women whip us: *baútendakami dagiti bakét.*

b. When either the subject or the object has to be emphasized, it takes first place, and the other members of the sentence follow in the same order: First, the verb; then, the remaining term. In this case, the emphasized term is connected with the rest of the sentence by the ligature *ti.*[3]

siák ti mañgála ití bagás: it is I who take rice.
ti bagás ti aláek: the rice is what I take.

NOTE 2. Sometimes it may be convenient to have either the subject (in both voices), or the object (in the substantival voice), precede the sentence; but this can only be known through frequent practice. In this case, whenever the subject precedes, it has to be repeated in the sentence in the shape of either a personal pronoun (adjectival voice) or a possessive (substantival voice) of the 3d person.[4] Examples.

dagití bakét agbáutda ití ubíñg:	the old women, they beat the child.
dagití bakét baútenda ti ubíñg:	the old women, they beat the child.
ti ubíñg baúten dagití bakét:	the child, the old women beat it.

II. A. As to the use of the two voices, it may be said in general that the adjectival construction is preferred whenever the stress is either on the action or on the one who does it, the

[2] To have and to be in Iloko. Philip. Journ. Sci. **66** (1938) 436.
[3] Ibid., p. 424.
[4] Ibid., p. 423.

subject, while the substantival construction is preferred whenever the stress is on the thing that has to be done, the object.

1. If the Iloko wants to say: I take rice, emphasizing the taking and leaving the term "rice" indeterminate, he will use the adjectival voice, thus:

mañgálaak ití bagás: I take rice (any rice).

2. If he wants to say: "I take rice," "I" and not somebody else, he will again use the adjectival voice:

siák ti mañgála ití bagás: it is I who take rice.

3. If he wants to say: "I take the rice," emphasizing "the rice" or making it entirely determinate, he will use the substantival voice:

ti bagás ti aláek: the rice is what I take.
aláek ti bagás: I take rice (not any kind of rice).

B. To explain more clearly what is meant by determinate and indeterminate:

1. If the Iloko wants to tell somebody to bring him rice, meaning any rice (indeterminate), in which case the action of taking is more important than the rice that has to be taken (the object), the stress being consequently on the action, he will use the adjectival voice and say:

mañgálaka ití bagás: take rice.

2. If he wants to tell somebody to bring him a certain kind of rice; that is, rice that has been spoken of before (determinate), in which case the rice that has to be taken (the object) is more important than the action of taking, the stress being consequently on the object, he will say:

aláem ti bagás: take the rice.

C. We may now draw the following rules, which are general, and without exceptions, and which cover the whole field of the Iloko verbal system:

1. The adjectival voice is used:

a. When there is no object (intransitive verbs); stress on the action. Examples:

uminúmak	I drink.
agtaráyka	you run.
nañgán	he ate.
makaáñgeskami	we can breathe.
makikúyogtayo	let us go with him.

pusáen ti tinápay	the bread is being eaten by the cat.
agpaágasta	we go to the doctor.
dumakkélkayo	you grow.
matúrogda	they sleep.
kimmagát ti áso	the dog bit.

b. When the object follows the verb and is more or less indeterminate; stress on the action. Examples:

uminúmak ití danúm	I drink water (any kind of water).
agbásaka ití líbro	read a book.
mañgarámidkami ití baláy	we make a house.
nakabírok ití bunéñg	he found a cutlass.
makisaóda ken Pédro	they talk with Peter.
agpataráytayo ití kabáyo	let us make the horses run.
sumakáyta ití báka	let us mount a cow.
nagisúratkayo ití inbagák	did you write down what I said?
umúli ití atépna	he climbs on its roof.
agsápul ni Juán ití pagiddaánna	John looks for a place for him to lie down.

c. When the subject precedes the verb; stress on the subject. Examples:

siák ti uminúm	it is I who drink.
siká ti mapán	you are the one who goes.
isú ti mayát	he is the one who is willing.
asíno ti agsáñgit	who weeps?
ti áso ti nañgála ití kárne	the dog is the one who took the meat.
awán ti nakabírok	nobody found it.
ti danúm ti nañgdadáel	the water spoiled it.
dakamí ti dimmakkél	we are those who grew.
dagití napán idiáy Bontók ti namapátay ití púsa	those who went to Bontok were those who killed the cat.

2. The substantival voice is used:

a. When the object follows the verb and is determinate; stress on the object. Examples:

inumék ti danúm	I drink the water (not any kind of water).
kaném daytá tinápay	eat that bread.
alàen ni Juán ti pirákna	John takes his money.
asinánmi ti kárne	we salt the meat.
sagádanda ti kuárto	they sweep the room.
ipányo ti ikán idiáy baláy	carry the fish into the house.
ibagáyo ti kayátyo	say what you like.
pagdigúsentayo ti nuáñg	let us bathe the carabao.
paarámidta ti lakása	let us have the trunk made.

b. When the object precedes the verb, stress on the object. Examples:

danúm ti inumék	water is what I drink.
isú ti surótem	he is the one you follow.

otóñg ti ginátañgda	cowpeas are what they bought.
saán a daytóy ti kayátyo	this is not what you like.
asíno ti baútenna	whom does he whip?
ni Juán ti bináonta	John was the one we sent.
dagití púsa ti ayabántayo	the cats are what we call.
baláy ti bañgónenmi	a house is what we build.
bunéñg ti birókek	a cutlass is what I look for.
dakamí ti tulàdenyo	we are those you imitate.
awán ti nasapúlanna	he found nothing.

II. PREFIXES, INFIXES, AND SUFFIXES

Almost all simple prefixes, infixes, and suffixes allow combinations with other prefixes, infixes, and suffixes; we shall give the most important and characteristic ones under each simple prefix, infix, and suffix. Combinations of adjectival prefixes, infixes, and suffixes with substantival ones will be studied under the latter.

THE ILOKO ADJECTIVAL VOICE

1. THE PREFIX *AG*

a. THE SIMPLE PREFIX

I. Form of the present: the prefix *ag.* Form of the past: the prefix *nag.*

II. A. This is the most used of all prefixes, infixes, and suffixes for verbs used in the adjectival construction, and verbal stems that do not allow it are rather scarce. It is really the one almost universal prefix for intransitive verbs in the Iloko adjectival voice. Examples:

agsáñgitak	I weep.
nagsaóka	you spoke.
agsaríta	he talks.
nagkatáwa dagití balásañg	the girls laughed.
agísem ti lakáy	the old man smiles.
nagsápulda ití tabáko	they looked for tobacco.
nagsúrat ni Ana	Ann wrote.
agtaráytayo ámin	let us all run.
agbásakayo	read.

B. This prefix is used especially:

1. With names of instruments, and forms a verb meaning: to use a certain instrument. Examples:

agdaklískami	we fish with a dragnet.
nagkatámda	they planed.
agragádi ni António	Anthony saws.
dakám ti agpandarás	we are those who cut with an adze.
nagságad	he used the broom.

asíno ti nagarádo	who plowed?
agbiolín ni Félix	Felix plays the violin.
nagsílaw dagití limmábas	those who passed carried a light.
agpaétda	they chisel.

2. With names of plays and games, and forms a verb meaning: to play a certain game. Examples:

agsúnayda	they spin tops.
nagsugál ni kabsátko	my brother gambled.
aglípay dagití ubbíñg	the children play at *lipay* (fruits used as marbles).
agkudókami	we play at *kudo* (pebbles used as jackstones).
nagtañggákayo	you played at pitchpenny.
dagitá ti nagsípa	those played at *sipa* (a kind of football).
agsintíkta	let us play at marbles (flipping).
nagkiñgkíñg da Juána	Joan and her companions played at hopscotch.

3. With names of clothing, ornaments, and forms a verb meaning: to wear a certain piece of clothing, and so on.

agbádoka	put on a coat.
nagsapín ni ádiñgko	my younger brother wore pants.
díka agkallogóñg	do not wear a hat.
isúda ti agsiñgsíñg	they are those who wear rings.
agulés ni gayyémko	my friend wears a blanket.
nagarítos dagití babbái	the women wore earrings.
agsagaysáyda	they wear combs.
ápay ñga agpáyoñgkayo	why do you carry an umbrella?

4. With names of fruits without owner—fish, and the like, and forms a verb meaning: to gather a certain kind of fruit, to catch a certain kind of fish, and so on.[5] Examples:

napánkami nagtabúñgaw	we went to gather bottle gourds.
íntayo agbisukól	let us go and gather pond snails.
agrasáda	they gather crabs.
agnatéñgta	let us gather vegetables.
nagkuritá da gayyémko	my friend and his companions gathered cuttles.
nagbayábaskami	we gathered guavas.
siák ti napán nagdaláyap	I went to gather lemons.
nagbilísda idí kalmán	they gathered sardines yesterday.

5. With names of ailments, and forms a verb meaning: to be affected by a certain kind of ailment. Examples:

agsakítak	I am ill.
aggurígur ni áma	my father has fever.

[5] Reduplication of Verbal Stems, II, 1, Note. Unpublished.

naggaddílkami ámin	we all had itch.
agsárut ti asáwana	his wife has consumption.
nagpúdotka itáy	you had fever a while ago.
aguyék	he coughs.
nagsíkada idiày	they had dysentery there.
nagburtóng idí ubíñg pay láeñg	he had smallpox when he was still a child.

6. With names of positions, occupations, trade, and so on, and forms a verb meaning: to have a certain position, to follow a certain profession and the like. Examples:

agsekretário ni ulitégko	my uncle has the position of secretary.
nagsoldádo dagití kaaróbak	my neighbors were soldiers.
agallawágida	they are carpenters by trade.
agokóm ti kaádalko	my classmate has the position of judge.
napán nagmédiko	he went to practise medicine.
agmáestra ni Isabél	Elizabeth is a teacher.

7. With stems usually formed into adjectives, or adjectival verbs in *ma,* and others, and forms a verb indicating the action corresponding to the state implied by the adjective, and so on. Examples:

agbulsék	he becomes blind.
agsiñgpétkayo	be virtuous.
nagánusda	they suffered it patiently.
agpílay ni Juán	John limps.
díka agbayág	do not be long.
agragsáktay ámin	let us all rejoice.
naginályadkami	we went slowly.
nagdarásta únay	we went very fast.
agsadút	he has a fit of laziness.
agpatáy ni gayyémko	my friend is dying.
dagití nagawán	those who died.

8. With numbers, and forms a verb meaning: to reach, for example, a certain number. In the past tense these verbs obviously mean: to be a certain number, because what became ten, twelve, and so on, also is ten, twelve, and so on. Examples:

aguppátda	they reach the number of four.
nagwalókami	we were eight.
agtalló púlo a tawén	he reaches his thirtieth year.
nagsiám a gasútda ñga immáy	they came nine hundred in number.
agduá a salúp	it amounts to two gantas.

b. COMBINATIONS

I. All these combinations form their past in the same way as the simple prefix *ag,* by changing *ag* into *nag:*

II. Nearly all forms of substantives, adjectives, numbers, and the like, allow the prefix *ag* to form intransitive verbs, with the same meanings as those explained under the simple prefix *ag*, especially II, B, 7 and 8. Examples:

nagkastóykami	we acted this way.
agpañgólo ti maysà	one takes the lead.
nagginasútda	they were (going) by hundreds.
nagsañgapúlokami	we were ten.
agmaúyoñg ni Francísco	Francis becomes insane.
nagpakinákemda ití dákes	they had bad intentions.
agdapoén daytá manók	that chicken becomes of a grayish color.
agtarikáyotayo	let us gather timber.
agkabannuág	he is at his full strength.
agbumaró	to become a young man.

III. Here follow some of the most noteworthy combinations:

A. Forms alluded to before; the prefix *ag* is used:

1. To form coördinate words and the plural of adjectives; these forms have been explained under the adjective.[6] Examples:

agkalúganda	they board the same car.
agkasinnalísal da Juán ken Antonio.	John and Anthony are rivals.
nagkapitlókami	we were third cousins.
agkalínasda	they pull the same string (they are of one mind).
dída agkaawátan	they do not understand each other.
agkainnawátanda	they understand each other.
dagití agkakadákes	the bad ones.
dagití agkakaíñgel a soldádo	the valiant soldiers.

2. With the combinations indicating reciprocity, rivalry, and so on. Examples:

naglinnímedda	they hid from one another.
nagpinnakawánda	they forgave one another.
agtinnúloñgtayo	let us help each other.
aglinnaíñgtayo	let us emulate one another in cleverness.
aginnápalda	they envy one another.
agkitankítada	they look at one another.
nagtuloñgtúloñgkami	we helped each other.
díkay agsusiksúsik	do not dispute with one another.
nagtuñgpatuñgpáta	we slapped one another in the face.
agkarinkarída	they make promises to one another.

[6] III. Special Forms, 1: coördinate words, IV; general remarks, II. Anthropos 26 (1931) 480–481, 485–486.

agkablankabláawda	they salute one another.
agtulidtúlid	it turns over and over.
aglinnukmeglukmégda a duá	both vie with one another in fatness.

3. With forms indicating resemblance, imitation, and so on. Examples:

agsinanpádi láeng̃	he is only a fake (not a real priest).
nagsinansábung̃	it had the shape of a flower.
agsinanmayát ni José	Joseph acts as if he was willing.
agmarasiksikan ti sáka ti baniás	the legs of the iguana are covered with scales.
agmarasinádag daytá sabá	that banana tree is leaning.
agmaragampáng̃ ni Catalína	Catherine is very frivolous.
agmarabettakán	it is nearly fissured.
agmaratamnáy	it tastes rather flat.
nagkaskastílakami	we acted like Spaniards.
agsang̃sang̃láytayo	let us imitate Chinamen.
naglallaláki ni Margaríta	Margaret wore men's clothes.

4. Sometimes with the prefix *si* including the notion of concomitance. Examples:

nagsiwará dagití tattáo	the men scattered.
agsitáng̃adkayo	look up.
agsiwarnák	he publishes the news.
agsiwáras	he distributes things.

5. With the suffix *an* in a very few cases; then the original meaning of the word in *ag* becomes stronger and more important. Examples:

agbelladán	he is overfed.
aglippiásan a panagyáman	an overflowing gratitude.
díkay agub-ubing̃án	do not act like children.
agkanibusánan ti biàg	life is at an end.
agnakmánka	be full of prudence.

B. New forms:

1. The prefix *ag* is used with the prefix *tagi* to indicate property or possession.

agtagibunéng̃ ni apók	my grandfather carries a cutlass.
nagtagigayáng̃da ámin	they all carried spears.
agtagipaltógtayo	let us carry a gun.
isú ti nagtagikuá	he was the owner.
agtagiláko	she sells (that is, a saleswoman).
nagtagipuráwda	they were clothed in white.
agtagibaláy	she looks after the house.
agtagianákka kaniák	consider me as your child.

2. The prefix *ag* is used with the prefix *in,* to form verbs meaning: to pretend to be so and so. Stems joined to the com-

plex prefix *agin* have their initial open syllable reduplicated, and, when they begin with a vowel, a glottal catch is placed between the complex prefix and the stem. Examples:

aginbubutéñg	he pretends to be afraid.
aginsasáñgit láeñg	he just pretends to weep.
patináyon ñga aginsasakít dagidiáy	those ones always pretend to be ill.
aginpipílay ta nasadút	he simulates lameness because he is lazy.
naginbubulsékkami	we simulated blindness.
bay-ám ta agintutúleñg láeñg	leave him because he only pretends to be deaf.
díka agbutéñg, aginbabáut láeñg	do not be afraid, he only pretends to whip.
aginbabannógkayo	you pretend to be tired.
aginbabaín	he simulates shame.
agindidiammó	he simulates ignorance.
nagin-aápalda	they pretended to be jealous.
agin-uuñgét	he simulates anger.
agin-aáwatda	they pretend to understand.
agin-iisú	he is presumptuous (literally: he pretends to be he).

NOTE 3. The complex prefix *agsin*, with the same modification of the stem and use of the glottal catch as noted with the preceding form, and the complex prefix *agsin . . . inn* indicate rivalry, reciprocity, and so on; but these forms have become almost antiquated. The same may be said about the combination *agsin . . . an*, meaning: to be mixed with, and so on. Examples:

agsintutúloñgda	they help one another.
agsinpipinnatigmáankami	we counsel one another.
agsinlalakián dagitá babbái	those women mix with men.

2. THE INFIX *UM*

I. Form of the present: the infix *um*. Form of the past: the infix *imm*.

II. A. This is a much used infix for verbs used with the adjectival construction, and, when used with stems that allow the prefix *ag*, it indicates an action of less duration, importance, or the like, than the latter. For example, *agtugáw*, to sit: *tumugáw*, to sit down; *agtakdér*, to stand; *tumakdér*, to stand up. Examples:

uminúm ti áso	the dog drinks.
umúlika	come up, come in.
immúlogkami	we went down, we left the house.
díka sumuñgbát	do not answer.
tumaráykayo	run.

napán immisbú	he went to make water.
tumakkí ti nuáñg	the carabao defecates.
lumúganta	let us climb in.
sumakáyda ití kabáyo	they mount horses.
gimmátañg ití bagás	she bought rice.
umísem	he smiles.
basáem ti sumaridát	read the following.
sumúrotka kaniák	follow me.
dumsáagkayo	alight.

B. This infix is used especially:

1. To translate the English: to grow (more), to become (more). Examples:

dumakkél ti ubíñg	the child grows.
lumakáy datáo	one ages.
bumassít ti bagàs	the rice diminishes.
umadú ti áso	the dogs increase.
immatiddág daytá	that grew longer.
umababá ketdí	it rather grows shorter.
immátap ti nuáñg	the carabao became wild.
umámo ti bákes	the monkey gets tame.
lumamíis ti danúm	the water cools down.
sumayáat	it becomes better.

2. To form verbs which indicate the threatening of an action rather than the action itself. In English when one says: that dog bites, it does not necessarily mean that he is actually biting. The Iloko have two different ways to render both meanings: *agkagát,* he actually bites; *kumagát,* he threatens biting. Examples:

bumáut daytá lakáy	that old man threatens whipping one.
tumúdo	it threatens rain.
kumagát ti ásoyo	your dog bites.
sumipát ta bakét	that old woman threatens slapping one.
bumugták ni Juán	John threatens scolding.
kumábil	he threatens beating one.
lumabága daytá	that one turns red.

NOTE 4. A similar notion is included in a few adjectives or substantives, formed with the infix *imm:* they indicate resemblance with what the stem implies. Example:

simminublán	something resembling a sinublán pot.

3. THE PREFIX *MAKA*

I. Form of the present: the prefix *maka.* Form of the past: the prefix *naka.*

II. This prefix is used:

1. To indicate active possibility, and, when used with the form of the past, to indicate completion of the action. Examples:

makaúliak	I can climb up.
saànak a makataráy	I cannot run.
makasañgpétkayonto	will you be able to come home?
díak makapagná	I cannot walk.
dída makakutí ití butéñg	they cannot move through fear.
idí ubíñgak nakataráyak	when I was a child I could run.
saán pay a nakapagná idí kalman	he could not yet walk yesterday.
nakadánon idiáy Alílem	he arrived at Alilem.
nakapánen	he went already.
nakarubbuátkami	we finished our preparations for the journey.
nakadáit	she finished sewing.
nakainúmka	did you drink?

2. To indicate natural needs. Examples:

makatúrog ni Juán	John is sleepy.
nakainúmak únay	I was very thirsty.
rimmuár ta makaisbú	he went out as he wants to make water.
makatakkí daytá áso	that dog wants to defecate.
makatabákoda	they want a smoke.
makakatáwa ni Ana	Ann feels like laughing.
makasáñgit ti ubíñg	the child feels like weeping.

3. To indicate ordinary effect; in this case the initial open syllable of the stem is sometimes reduplicated. Examples:

ti básol a makapatáy	the grievous sin (literally: the sin that kills).
makaágas daytá a róot	that herb has curative power.
díka agtàkaw aniá la ketdí ta makabásolka	do not steal lest you commit a fault.
nakatipéd daydiáy	that one was an impediment.
makaúma	it is tiring.
makasúya ti tabá	fat causes nausea.
makatutúdo	it causes rain.
makasasadút daydiáy	that makes one lazy.

4. With cardinal numbers, to indicate how many of a certain class one wants to buy, one takes, how many of a certain class something can contain, and so on. With the numbers in *kanika*, the prefix simply becomes *makanika*.[7] Examples:

makatallóak	I want to buy three.
nakapitókami	we took seven.
makaduá daytá karretón	that cart holds two.
nakalimá kanó	it is said to have been able to hold five.
makanikaduá púloda ket duá	they want to take twelve.

[7] The adverb, II; adverbs of time, III. Unpublished.

III. The prefix *makapag* (past: *nakapag*) : This prefix is used with stems that allow the prefix *ag* to indicate that the action implied by the stem is or is not impeded by an obstacle from without (physical inability). For examples, *díak makasúrat,* I cannot write (because I did not go to school, or for some similar reason) ; *díak makapagsúrat,* I cannot write (because I have no pen, people push me, my arm is broken, or for some similar reason). Examples:

saánda a makapagálad	they cannot make a fence.
díkam nakapagtugáw	we could not sit down.
díak nakapagtúloñg	I could not help.
saánkam a makapagkatáwa	we cannot laugh.
makapagtaráykayo ditóy	can you run here?
saánkayo a makapagsúrat ta agginginéd	you cannot write because there is an earthquake.
saánkami a nakapagsaríta ta adú ti ubbíñg	we could not talk as there were many children.

NOTE 5. *a.* The combination *makapag . . . inn* (past: *nakapag . . . inn*) of reciprocity, and the complex prefix *makapagin* (past: *nakapagin*) of pretending, both derived from the preceding, are rarely used. Examples:

saánda a nakapagkikinníta	they were not able to see each other.
díak makapaginpipílay	I cannot pretend to be lame.

b. The prefix *makapañg* (past: *nakapañg*) differs from *makapag* in the same way as the transitive prefix *mañg* differs from the intransitive prefix *ag.* Examples:

makapamárut daytá manók	that chicken sheds its feathers.
nakapañgdúsa kaniàk	he could punish me.

4. THE PREFIX *MAKI*

a. THE SIMPLE PREFIX

I. Form of the present: the prefix *maki.* Form of the past: the prefix *naki.*

II. This prefix is used:

1. To indicate that something is done with others. Examples:

makisarítakam kenkuána	we talk with him.
napánda nakisugál	they went to gamble.
íntayo makibúya	let us go and see (the performance).
makikúyogka	go with (him).
nakipán ni Luís	Lewis also went.
madída a makitúlag	they do not want to make a contract.
nakiasáwa ni Ana	Ann married.
ínta makiáni	let us go to participate in the harvest.
kayátko ti makisaó	I want to talk with (you).
makilásinka iti daytóy	keep away from this one.
napán nakigubát	he went to war.

NOTE 6. Note the difference between the two expressions:

agápa da Juán ken António	John and Anthony quarrel.
makiápa ni Juán ken António	John quarrels with Anthony.

2. To indicate that somebody treats a person as his father, friend, or the like, according to the meaning of the stem. Examples:

makiádi kaniák	he treats me as his younger brother.
makiamákami kenkuána	we treat him as our father.
makigayyémda ken Juán	they make friends with John.

3. With stems meaning "to ask," without changing the latter's meaning. Examples:

makidáwatka ití àrak	ask for wine.
nakidáwatda ití kuárta	they asked for money.
nakirañgkápda iti suñgród	they asked for fuel.
makirañgkápkami ití natéñg	we ask for vegetables.
ínka makisaludsúd	go and ask.
makiintúodak	I ask.

4. With names of fruits, and the like, and forms a verb meaning: to ask for a certain kind of fruit, and so on. Examples:

makinatéñgka	ask for vegetables.
makibayábastayo ken Juán	let us ask John for guavas.
nakitabákoak ken áma	I asked my father for tobacco.
ínkayo makisidá	go and ask for viands.

b. COMBINATIONS

I. All these combinations form their past in the same way as the simple prefix *maki,* by changing *maki* into *naki.*

II. The prefix *maki* is used:

1. With the prefix *ka* and with the combination *ka . . . an,* indicating companionship. Examples:

makikatugáwak kenká	I sit down with you.
makikabbaláykami ken Juán	we live in the same house with John.
nakikaiddá kaniák	he lay down with me.
makikadáratayo kenkuána	we are of the same blood as he.
makikabagiánda kaniák	they are relatives of mine.

2. With the combinations indicating reciprocity, rivalry, and so forth. Examples:

makisinnakláñg ken amána	he faces his father.
makisinnúratda ití gayyémda	they write to their friend and vice versa.
nakitinnúlagda	they made a contract.
makiinníliw	he longs to see (him) and vice versa.

makilinniñgáy kaniák	he gives me some distraction and vice versa.
makibinnílañgda kenkuána	they count it over with him.
makibalanbalákad	he gives good advice and receives it.
makiammoammó	he becomes an acquaintance.
makitapkitapkíl kadagití babbái	he mixes with women.
makipinnatenpatégak kadakayó	I prize you very much and vice versa.

3. With the infix *um,* and forms a verb meaning: to desire, to have a longing for what is expressed in the stem. Examples:

makisumarítaak	I want to talk.
makikumítada ití balàyko	they want to see my house.
makiuminúmkami	we want to drink.
makidumámag	she wants to ask for information.

III. The prefix *makipag* (past: *nakipag*) : This prefix is used with stems that allow the prefix *ag* to indicate that the action implied by the stem is performed in the company of somebody who himself performs it in the company of others. For example: *kayátko ti makisaó kenkuána,* I want to have a talk with him; *ínnak makipagsaó,* I shall go with (you) to have a talk with (him) ; *bay-ám ta makisaríta kaniák,* let him be, so that he may have a talk with me; *adú ti makipagsaríta,* many people join (him) to have a talk with (you). Examples:

makipagtáwidda kaniák	they are my coheirs.
nakipagmaymaysá kadakamí	he was one with us.
makipagpúyatkay kaniák	watch with me.
nakipagtúlag kadakuáda	he arranged the contract with them.
nakipagbiág kadatayó	he lived with us.
idí napának nakimísa nakítak a nakipagmísa ni apó Antonio	when I went to hear Mass, I saw Father Anthony saying Mass also.

NOTE 7. *a.* The combination *makipag . . . inn* (past: *nakipag . . . inn*) of reciprocity, and the complex prefix *makipagin* (past: *nakipagin*) of pretending, both derived from the preceding, and the complex prefixes *makisin* and *makisin . . . inn* of reciprocity are rarely used. Examples:

makipagtitinnúloñgkayo	join them in helping one another.
nakipagintutúleñg	he also pretended to be deaf.
makisinpapatigmáankami	we counsel one another.

b. The prefix *makipañg* (past: *nakipañg* differs from *makipag* in the same way as the transitive prefix *mañg* differs from the intransitive prefix *ag.* Examples:

íntayo makipamonpón	let us go to the funeral.
dagití makipañgúyog	the companions.
nakipañgrabíi	he had supper with them.
napán nakipañgán kenkuána	he went to eat with him.
nakipañgdalús kadagitá	he helped cleaning those.

5. THE PREFIX *MAÑG*

I. Form of the present: the prefix *mañg*. Form of the past: the prefix *nañg*.[8]

II. A. This prefix is used chiefly to change into the adjectival construction a great number of verbs, which are ordinarily construed substantivally and which, for one of the reasons explained above, have to become adjectival. Most of the prefixes of the substantival verbs are combined with the prefix *mañg*, whenever the construction has to be changed into the adjectival voice; therefore we shall give explanations and examples of the use of this particular prefix later on.

B. The prefix *mañg* is used especially:

1. With names of fruits without owner, fish, and the like, and forms a verb meaning: to gather a certain kind of fruit, to catch a certain kind of fish and so on.[9] Examples:

íntayo mañgáyo	let us go and gather wood.
napánda nañgróot	they went to get grass.
umáykami mañglánot	we come to get vines.
nanuñgródda	they gathered fuel.
ínka mañgípon	go and catch *ipon* (a kind of very small fish).

2. To form verbs meaning: to buy something in general. Examples:

íntayo mañgnuáñg	let us go and buy carabaos.
umáyda mañgápas	they come to buy cotton.
mamàka ti kayátda	buying cows is what they want.
napánda nañgmanók	they went to buy chickens.
ínta mamágay	let us go and buy rice.

3. With words indicating the worth of something in money, and forms a verb meaning: to be worth each a certain amount. Examples:

manalapí	they are worth fifty centavos each.
mamísos daytá	that is worth a peso.
manikápat	they are worth twelve centavos each.

4. In some other cases. Examples:

mañgán ni Juán	John eats.
mamigátkami	we breakfast.
nañgaldáwkayon	have you had lunch?
ínkayo mañgrabíi	go and take your supper.

[8] Notes on Iloko. Anthropos 23 (1928) 1037, 1038.

[9] Reduplication of Verbal Stems. II: 1, Note. Unpublished.

6. THE PREFIX *MA*

a. THE SIMPLE PREFIX

I. Form of the present: the prefix *ma.* Form of the past: the prefix *na.*

II. A. This prefix is used chiefly for the passive voice, and practically every prefix and suffix of the Iloko substantival voice may be combined with it; therefore we shall give explanations and examples of the use of this particular prefix later on.[10]

B. The prefix *ma* is used also:

1. To indicate passive possibility (with the form of the present). Examples:

makíta ti baláy	the house can be seen.
saán a madáit	it cannot be sewn.
matarimáan pay	can it still be repaired?
saán a matilíw ti kabáyo	the horse cannot be caught.
saán a maibús daytá	that cannot be used up.
maála	can it be taken?
saán a maúray	it cannot be waited for.
di matúkod	it cannot be fathomed.

2. In some other cases. Examples:

madíkami	we won't.
natúrogda	they slept.
mabalín	it is possible.
masápul	it is necessary.
masakít ti anàkko	my child is ill.
nabisínkayo	were you hungry?
nawáwkami	we were thirsty.
masdáawda	they are astonished.
naúma dagití gayyémko	my friends got tired of it.
nabátida idiáy ílida	they remained in their town.
masúya ni Santiágo	James nauseates.
maariékkami	we sicken at it.
mapúrarda	they are dazzled.
awán ti nabáti	nothing remained.

b. COMBINATIONS

1. The complex prefix *masi* or *masin* (past: *nasi* or *nasin*) has the notion of concomitance combined with the original meaning of the prefix *ma.* Examples:

masidadáankami or *masindadáankami*	we are waiting obsequiously, we are ready.
masitammél daytá ubíñg	that child is struck dumb.

[10] The Substantival Prefix *ma.* Unpublished.

2. When the suffix *an* is joined to a verb in *ma* this combination (past: *na . . . an*) very often indicates either a completion, an intensification of what the verb with the simple prefix *ma* would indicate, or the impossibility of performing it. Here also the suffix *an* retains its distinctive quality: it is a real locative, as may be clearly seen by some of the examples, for example: *ínit,* sun, *mainítan,* it lies in the sun; *napúdot,* it is warm, *napudótan,* it is full of heat; *mapúkaw,* it is lost, *mapukáwan,* he loses something. More will be said about this combination later on.

It should be remembered, however, that the suffix *an* of substantival verbs may be used together with the adjectival prefix *ma,* in which case the explanation of this construction will be found later on, as has been stated above. Examples:

narabiiánkami	we were overtaken by the night.
napudótan idiáy	it got thoroughly heated there.
mabisinán	he starves.
saán a masapúlan	it cannot be found.
mainítanto idiáy	it will lie in the sun there.
napukáwan ni Juán	John lost something.
napuyátan dagití ubbíñg	the children were awake too long.
nalam-ekán	he got thoroughly cold.
nasimataànak láeñg kenkuána	I only saw him with a glimpse.

3. When the prefix *ag* is joined to a verb which retains its own prefix *ma,* the first consonant of the latter is changed into *k,* and the complex prefix *agka* (past: *nagka*) gives the verb something of an active meaning; for example; *maañgínan,* it is exposed to the wind, *agkaañgínan,* he exposes himself to the wind. Examples:

ápay a napánka agkapudótan	why did you go to become entirely hot.
nagkaañgínanda	they exposed themselves to the wind.
agkainítan ni António	Anthony (lies) in the sun.
agkapitákan	he gets himself covered with mud.
agkarugitán	he dirties himself.
agkatudoán	he (stands) in the rain.
agkalimdoósan	he gets himself covered with cold sweat.
agkadinámag ti pintásna	her beauty is renowned wide and far.

7. THE PREFIX *KARA*

I. This prefix has no special form for the past.

II. The prefix *kara* is used to indicate that the action implied by the stem is repeated frequently. Examples:

karaáwid ti gayyémko	my friend goes home continually.
karaumáy	he comes all the time.

III. The prefix *kara* may be combined with the prefix *ag* (past: *nagkara*) and with the infix *um* (past: *kimmara*), and the difference between the two is the same as that between *ag* and *um*.

agkarasublí ti lúgan	the cart comes back continually.
agkarabóoñg daytá piñggán	that plate gets cracks all the time.
agkaraáwid	he goes home continually.
agkaraumáy	he comes all the time.
nagkarapugsát ti talí	the rope snapped all the time.
kumarasublí	it comes back continually.

8. THE INFIX *AN*

I. This infix, in the adjectival voice, occurs only in combinations either with the prefixes *ag, agka,* or *ma,* or with the infix *um;* the form of the past of the original prefix or infix is retained in these combinations.

II. The infix *an* is used to form verbs indicating repetition, intensity, and so on, of actions, especially of sounds.

When the infix *an* is used with the complex prefix *agka,* the action or sound indicated by the word is produced by more individuals, for example, than when it is used with the simple prefix *ag;* the second prefix *ka* stands either for companionship or plurality.

When the infix *an* is used with the infix *um,* the action or sound indicated by the word is of shorter duration and more often repeated than when it is used with the prefix *ag.*

The prefix *ag* and the infix *um* have an active meaning, the prefix *ma* has a passive one. Examples:

agsanultíp	he blows a whistle with force.
agbanítog	he thumps.
agranetrét ti rikép	the door creaks.
agkanuskús	he gathers to himself.
nagbanetbét	he struck with force.
agkabanetbétda	they strike with force.
bumanorbór ti karayán	the river roars.
dumanasádas	it rustles.
kimmanagkág ti pandilíñgna	her skirt rustled.
tumanogtóg	he knocks repeatedly.
bumanerbér ti áñgin	the wind roars.
bumanítog	he thumps repeatedly.
wumaneswés	he whirs along.
sumanigkí	he sits up with a sudden jerk and sighing.
kumanagkág ti selláy	the moon shines bright.
nakanagkág ti selláy	the moonlight was very beautiful.

NOTE 8. Very common forms, more or less onomatopoetic, and chiefly used for verbs indicating repetition or intensity of sound, have been explained in Notes on Iloko.[11]

The difference of the complex prefix *agka* and that of the simple prefix *ag* consists here also in the notion of plurality, which is included in the prefix *ka;* this notion of plurality bears on the cause or origin of the action or sound.

The infix *um* here also indicates a slighter action or sound than the prefix *ag*.

The prefix *ag* and the infix *um* have an active meaning, while the prefix *ma* has a passive one.

a. The forms with repetition of the initial consonant. Examples:

agbabtóog	he thumps.
nagkaktóol	he knocked noisily.
nagkababtóogda	they thumped.
agkakaktóol dagití ubbiñg̃	the children knock noisily.
agkakaklíiñg̃da	they jingle.
agkararpáakda	they bang.
nababtóog ti niúg	the coconut thumped.
makaktóol	it knocks noisily.
makaklíiñg̃	it clinks.

b. The forms in *n*, where the infix *an* remains distinctly apparent: *agkana, mana*. Examples:

agkanabtóogda	they thump.
nagkanaktóol dagití sapátosna	his shoes knocked noisily.
agkanaklíiñg̃da	they jingle.
agkanalpíitda	they clap.
agkanakláañg̃da	they clang.
agkanaltóogda	they crepitate.
nanabtóog ti niúg	the coconut thumped.
manaktóol	it knocks noisily.
manaklíiñg̃	it clinks.
manaltóog	it crackles.
manalsíit	it spits.

c. The forms without repetition of the initial consonant. Examples:

agrittóok	it cracks.
nagrittíik	it cracked.
agrottóok	it cracks.
lumtáak	it clacks.
lumtóog	it cracks.
limsíit	it spat.

9. THE PREFIX *AGA*

I. This prefix has no special form for the past.
II. This prefix is used:

[11] Anthropos 23 (1928) 1039, 1040.

1. With stems meaning a part of the body, or the like, to indicate how far the water, a piece of clothing, or the like, reaches. Examples:

agasíket ti karayán	the water of the river reaches the waist.
agatúmeñg idí kalmán	it reached the knees yesterday.
agasíko dagití mángos ti bádok	the sleeves of my coat reach my elbow.

NOTE 9. Sometimes the prefix *paga* is used with the same meaning. Example:

pagateñgñgéd ti danúm	the water reaches the neck.

2. With stems meaning a substance which diffuses a certain odor, to characterize the smell of something. Examples:

agabáwañg ti ñgíwatmo	your mouth smells of garlic.
agaárakkayo	you smell of wine.
agalasoná ditóy	it smells of onions here.

10. THE SUFFIX *EN*

I. Form of the present: the suffix *en*. Form of the past: the infix *in*.

II. This suffix is used:

1. With stems indicating ailments, and the like, and forms a verb meaning: to feel the symptoms of a certain disease, for example. Examples:

gaddilén ti ubíñgko	my child gets itch.
burtóñgenak	I am getting the smallpox.
talimudáwen ni Juán	John is dizzy.
patináyon a rabíi alimbaságenak	every night I have the nightmare.
til-ién ti ubíñg	the child has hiccups.
saguyepyepénkami	we are overcome by sleep.
tinarobáayka itáy bigát	you were weak this morning for not having eaten last night.
talipuñgáwenak ditóy balày	I feel sad all alone in this house.
alimutñgénkayo	are you angry?
sakitén ti ólok	my head aches.
sakitén ti nákemko	I am sorry.

2. With names of parts of the body, or the like, and forms a verb meaning: this or that part of the body, aches, is sore, for example. Examples:

bakráñgen ti anákko	my child has pain in its side.
karabukobénda ámin	all of them have a sore throat.
sikétenak	I feel pain in my waist.
basisáwen ni Juán (from *basísaw*, bladder)	the water gurgles in John's belly (for having drunk too much of it).
rurusókenda (from *rúsok*, stomach)	they eructate.

3. With names of animals, or the like, to indicate that a certain animal has started eating, consuming, for example, something. Examples:

ináso ti kárne	the dog got at the meat.
kotonén ti inapúy	the rice is full of ants.
inánay ti lúpotko	my clothes were ruined by white ants.
puséen ti tinápay	the cat is eating the bread.
dináñgaw ti págay	the rice has been devastated by stink-bugs.
binokbók ti bagás	the rice is full of rice weevils.
ayaménak	my skin is irritated by chicken ticks.
kimatén ti káyo	the tree is struck by lightning.

4. To form verbs which indicate that the subject in question has the quality of what the stem implies. In this case the first open syllable of the stem is reduplicated. Examples:

babadoén daytá lúpot	that cloth is good for coats.
guguyóden ti nuáñgna	his carabao is good for drawing purposes.
aadigién toy kàyo	this timber is good for posts.
sasapatósen di lálat	that leather is good for shoes.
gagabúten	yard grass, *Eleusine indica* (literally, easily grubbed up, or: which has to be grubbed up).
dadanúgen	a variety of banana (from *dánug:* cuffing).
arámid a dinederrép	an act of concupiscence.
sinasarírit	it is full of wit.
iniilóko daytá súrat	that letter is written in Iloko.
kinakararuá	coming from the soul.
ti íma a linalaság	the arm of flesh.
binabái daytá	that one is like a female.

11. THE SUFFIX *AN*

I. Form of the present: the suffix *an.* Form of the past: the infix *in* and the suffix *an.*

II. This suffix is added to cardinal numbers and to the interrogative *manó,* to ask or indicate how many of a certain class one obtains. It is of very little use. Examples:

manoánka	how many do you get?
limaának a taróñg	I get five eggplants.
ininnemán	he got six.

NOTE 10. This suffix has sometimes the same meaning as the adjectival suffix *en,* under II, 4. Example:

arámid ñga inuubiñgán	a childish act.

12. COMBINATIONS WITH *TARI*, AND THE LIKE

I. These combinations have no special form for the past.

II. The prefixes *tari, tagi,* and *ari* or *arin* may be combined with the suffixes *an* and *en,* to indicate that the subject is very near or on the point of undergoing what the stem implies. Examples:

taribaútanak kenká	I am going to whip you.
tarianakán ni bakétko	my wife is near childbirth.
tagiloomán ti sabá	the bananas are nearly ripe.
ar-aripatayának	I am at the point of death.
ar-aribetbetànak	I was just going to strike.
ar-arimadiánka	you were going to refuse.
arinbabaútanka láeñg kaniák	you are always ready to whip me.
ar-arinpatayán	he is at the point of death.
arinturógen	he seems to be asleep.
arintutudoén	it is about to rain.

13. FREQUENTATIVE PREFIXES

I. These prefixes have no special form for the past.

II. The most important prefixes of the adjectival voice have a special form of frequentative which indicates a repetition, a successive performance, or an intensification of the action implied by the ordinary form of the verb.

When the simple prefix allows this frequentative form, so do also generally the complex prefixes derived from that simple prefix; so, for example, if the simple prefix *ag,* which allows this frequentative form (*manag*), is combined with other prefixes into *agin, agkara,* for example, the latter also allow the frequentative form of *ag* (*managin, managkara,* and others [12]).

The frequentative form derived from:

1. *Ag* is *manag.* Examples:

managsaludsúd ni Pedro	Peter always asks questions.
managsarítaka	you are quite a talker.
managsaóda	they speak very much.
managinúm ni Cristóbal	Christopher is a drinker.
managbarték	he is a drunkard.
dagiti managdáit	the seamstresses.
dagití managatép	the roofers.
managsáñgit dagitóy ñga ubbíñg	these children always weep.
managkatáwakayo la únay	you laugh to excess.
managísem ni António	Anthony always smiles.

[12] Notes on Iloko. Anthropos 23 (1928) 1037, 1038.

managságad ti anákko	my daughter has always the broom in hand.
managkiñgkíñgda	they always play hopscotch.
managulés ni daydiáy	that one always wears a blanket.
managpáyoñg da Artúro	Arthur and his companion always carry an umbrella.
managbayábasda ñga agkabsát	she and her sister always gather guavas.
managsakít ni íkitko	my aunt is always ill.
managgurígurkami	we always have fever.
managuyék ni Simón	Simon always coughs.
managánuska a táo	you are a very patient man.
managkastáta	let us always act that way.
managpakinákemda ití saán a rumbéñg	they always meditate what should not be.
managinnápalda	they always envy each other.
managsusiksúsik da Juán	John and his companions always dispute.
managtinnuloñgtúloñgda	they always help one another.
managsinanmadí ni gayyémko	my friend always acts as if he refuses.
managsitàñgadkayo	you always look up.
managtagibunéñg ni áma	my father always carries a cutlass.
managtagiláko ni Catalína	Catherine is always selling things.
siká ti managinpipílay	you are the one who always simulates lameness.
managintutúleñg dagití adálanna	his students always simulate deafness.
managin-iisú daytá babái	that woman is very presumptuous.

2. *Maka* is *mannaka*. Examples:

mannakabalín ámin ti Diós	God is almighty.
mannakabírok ni ína ití mapúkawko	my mother always finds what I lose.
mannakainúm daytá báka	that cow always wants to drink.
mannakatúrog ti asáwak	my wife is always sleepy.
mannakatipéd	it is always in the way.

3. *Maki* is *mannaki*. Examples:

mannakiriñggórka	you are always quarreling.
mannakiápa daytá ubíñg	that child always altercates.
mannakisugálda	they are gamblers.
mannakimísa ni ulitégko	my uncle always goes to Mass.
mannakidáwatda ití inumén	they always ask for water.
mannakisaludsúdda	they always ask questions.
mannakitabákoda	they always ask for tobacco.
mannakikaiddáda kenkuána	they always lie down with him.
mannakisinnúratda kaniák	they always write to me and vice versa.
mannakiammoammó	he always makes acquaintances.
mannakidumámagda	they always want information.
mannakipagdinnà kadakuáda	he also is always near them.

4. *Mañg* is *manañg*. Examples:

manañginanámakami a patináyon	we are always hopeful.
manañgrikná	she is tender, delicate.
ti mammadlés	the prophet.
dagití mammúyat	the watchers.
dagití mammáti	the faithful.
mammáut ni áma kaniák	my father always whips me.
manamátit ití kampána	he always rings the bell.
mannúratda	they are writers.
mananaóka	you speak very much.
mananákaw dagitá	those ones are thieves.
mananáitkayo	you are seamstresses.
dagití mañgñgálap	the fishermen.
mannañgán ni Ana	Ann always eats.
manañgñgaásida únay	they are very merciful.
isú ti mañgñgágas	he is the doctor.
mañgñganúp ni asáwak	my husband is a hunter.

14. SUBSTANTIVES INCLUDING VERBAL NOTIONS

I. Instead of using a preposition or some other construction to indicate: the instrument with which, the place where, the reason why, the person in whose behalf, the manner how, and the time when something is done, the Iloko has a series of prefixes and suffixes which add the afore-mentioned meaning of instrument, place, and so on, to the stem implying the action.

A. So, instead of saying: "She sews with a needle," which may be translated literally into: *agdáit ití dágum* the Iloko say ordinarily and more correctly: *pagdáitna ti dágum:* a needle is "the instrument with which she sews" (all in one word used as a predicate).

NOTE 11. This latter construction is ordinarily the more correct.

B. *a.* Instead of saying: "I sit on this stone," which may be translated literally into: *agtugáwak itóy batô,* the Iloko often say: *pagtugawák toy bató:* this stone is "the place where I sit."

b. Instead of saying: "Why does he weep?" which may be translated literally into: *ápay ñga agsáñgit,* the Iloko often say: *aniá ti pagsañgítanna:* "what is the reason why he weeps?"

c. Instead of saying: "He writes to me," which may be translated literally into: *agsúrat kaniák,* the Iloko may say: *pagsurátannak:* I am "the one to whom he writes."

NOTE 12. As may be seen by the above explanations, this construction is not always obligatory, and in some cases it is even preferable not to use it, because the meaning would not be clear; for example: *pagsañgítanna ti baláyna* may mean: he weeps in his house, and: he weeps on account of his house; consequently, it would be better to say: *agsáñgit idiáy baláyna,* and: *agsáñgit gapó ití baláyna,* respectively.

C. *a.* Instead of saying: "How does he write?" the Iloko say: *kasanó ti panagsúratna:* "how is his writing?"

b. Instead of saying: "When does he write?" the Iloko say: *kaanô ti panagsúratna:* "when is his writing?"

NOTE 13. This construction is very often obligatory.

II. These combinations are allowed with the most important prefixes of the adjectival voice. When the simple prefix allows them, so do also generally the complex prefixes derived from that simple prefix; so, for example: if the simple prefix *ag,* which allows these combinations (*pag, panag,* and others), is combined with other prefixes into *agin, agkara,* and others, the latter also allow these combinations of *ag* (*pagin, pagkara,* and others, *panagin, panagkara,* and others.[13]

A. The prefixes that indicate the instrument with which something is done are formed by changing the first consonant of the original verbal prefix into *p,* or by adding a *p* to the original prefix if it begins with a vowel. The forms of the past are the same as those of the present, except that the infix *in* is inserted after the initial *p* of the forms of the present.

The instrumental prefix derived from:

1. *Ag* is *pag* (past: *pinag*). Examples:

awán ti pagsúratko	I have no pen.
pagpúnasmi ti bádomi	we use our coat to wipe things.
nabasà dagití pagsukátko	my clothes (to change) are wet.
daytá an-anák ti pagay-áyamyo	play with that doll.
lapáyag a pagdeñgñgég	ears to hear.
aniá ti aláek a pagsílawko	what light do I take?
dákes ti pagragádimi	our saw is bad.
awán ti pagkatámko	I have no plane.
aniá ti pagságadyo ití kuárto	with what do you sweep the room?
pinagkiñgkíñgda ti bató	they used a stone to play at hopscotch.
aniá ti pagsapínko	what pants do I wear?
pinagbádona ti ginátañgko idí kalmán	he put on the coat I bought yesterday.
daytóy ti pagkàlapmi	we fish with this.
aniá ti pagkasdiáymo	with what do you do it that way?
awán ti pagginnúyodda	they have nothing with which to pull one another.

NOTE 14. When the initial open syllable of the stem is reduplicated, the prefix *pag* very often indicates:

[13] Notes on Iloko. Anthropos 23 (1928) 1037, 1038.

a. That something can be or has to be exchanged for what the stem implies. Examples:

pagpapágayko daytóy	I want to exchange this for rice.
pagpipirákmi dagití ilákomi	we want money for our wares.

b. That something is used for what the stem implies as a substantive, and not for what it implies as a verb. Examples:

pagtutúdo ti páyoñgko	my umbrella is for the rain.
pagiínit ta páyoñgmo	your umbrella is for the sunshine.
pagliliñg-ét toy lúpot	this cloth is for the perspiration.
paglalammín ti ulésmi	our blanket is for the cold.

c. That one desires what the stem implies. Examples:

pagkikítak ti baláyna	I long to see his house.
pagdadáwatna daytá áso	he longs to ask for that dog.
pagdadánonmo ti Kabúgaw	you long to reach Kabugaw.
paggigíbusmi daytóy bagás	we want to finish this rice.

2. *Maka* is *paka* (past: *pinaka*). Example:

pakaoná dagití masakbáyan	a presage of the future.

3. *Maki* is *paki* (past: *pinaki*). Examples:

asín ti pakikúyogmo	who is your companion?
pinakiálam daytá bagás	did you also take that rice?
ti pakiintúod	the question.

4. *Mañg* is *pañg* (past: *pinañg*). Examples:

aniá ti pañgatépyo ití balàyyo	with what do you roof your house?
díka pañgiddép ti danúm	do not use water to extinguish it.
isú ti pinañgáwisko kenkuána	that is how I allured him.
bagás ti pañgaráyatda ití napañg-láw	they help the poor with rice.
aniá ti pañganákko ití buniág	how can I be a godfather? (I have nothing.)
wásay ti pamútolna	he cuts off his head with an axe.
dakkél unáy a pinamaneknékda	a very great proof for them.
awán ti pinamáyadna	he had nothing to pay with.
aláem ti panáit a puráw	take white thread.
ti pañgsaksí	the testimony.
pañgaásim apó	please, Sir.
maysá a pañgñgárig	a parable.

NOTE 15. The prefix *pañg* or *pañgi* joined to names of towns, provinces, and the like, means that something is of use to the people of that town, province, and so on.[14] Examples:

pañglawág daytóy a kàyo	this timber is good for Laoag.
pañgagayán ti bagás	the rice is good for Cagayan.
pañgibañgár dagidiáy	those are good for the Bangar people.

[14] The Transitive Prefix *Mañg*. P. 9, Note. Unpublished.

B. The prefixes that indicate the place where, the reason why, and the person in whose behalf something is done, are formed in the same way as the instrumental prefix, but the suffix *an* is joined to the stem. The forms of the past are the same as those of the present, except that the initial *p* of the forms of the present is changed into *n*.

The combination derived from:

1. *Ag* is *pag . . . an* (past: *nag . . . an*). Examples:

adíno ti naguráyanyo kenkuána	where did you wait for him?
pagaládanda ti minuyoñgán	they fence the garden.
ditóy ti pagsubliánna	he comes back here.
intúgotna ti pagsarmíñgan	he took the looking-glass with him.
nadadáel ti pagsokogántayo	our mold is ruined.
aláem ti pagsiláwan	take the lamp.
aniá ti nagladiñgítam	why were you sad?
ti asók ti nagbaenák	I sneezed on account of the smoke.
kas pagarígan	for instance.
daytóy ti pagbabawiák	this is why I feel sorry.
asín ti pagapálanna	whom does he envy?
siák ti nagkamáñgam	you took shelter with me.
ti kaatiddágda ti naggiddiátanda	it was their length in which they differed.
sadíno ti pagariánna	where is his kingdom?
ti pagimbagánna ta nañgísit	it is a good thing that it is black.
daytóy ti pagdaksánna	this is the worst of it.
aniá ti nagbayagányo	where were you so long?
naglukaták ti kasañgsañgpét	I opened the door for the one who just arrived.
idiáy baláymi ti nagtarayánna	he ran to our house.
pagsagádanyo ti kuártomi	sweep our room.
idiáy ruár ti pagragadiányo	saw outside.
ditóy unég ti nagsintíkanda	they played at marbles inside here.
aniá ti nagsakitán ti asáwana	how did his wife get ill?
ti baybáy ti pagkalápantayo	let us fish in the sea.
aniá ti nagkastáanda	why did they do that?
paginnagáwanda ti bagás	they fight for the rice.
aniá ti paginnapálan da Mercéd	why do Mercy and her companion envy each other?
idiáy baláymi ti nagsusiksusíkanda	they disputed with one another in our house.
pagdamandamáganda ta nabayág a dída nagsasárak	they ask one another for news because it is a long time since they met.
adíno ti nagtinnuloñgtulóñganda	where did they help one another?
pagtagtagiammoán pay láeñg	it is still a doubtful matter.
sadíno ti naginbubulsekányo	where did you simulate blindness?
nagintutuleñgán ti ubíng ta nasadút	the boy simulated deafness because he is lazy.

ti pagindidiammoánna ta umaripapá	he simulates ignorance because he is shy.
paginsasaanánmi ta kayátdaka a kitkitáen	we simulate unwillingness because we want to see you.
anià ti pagkarasublián tay lúgan	why does that cart come back continually.
idiáy baláyyo ti pagkaraboóñgan ti piñggán	the plate gets cracks all the time in your house.
adíno ti pagsanultípanna	where does he blow a whistle with force?
aniá ti pagbanetbetánda	why do they strike with force?

2. *Maka* and *ma* is *paka . . . an* (past: *naka . . . an*). Examples:

nakauliák ti agdán	I climbed by the stairs.
sadín ti pakaulógam	where can you get down?
aniá ti díkayo nakaruáran	why did you not come out?
ti sakitko ti díak pakabasáan	I cannot read on account of my illness.
ti karayán ti dítay pakañggán	we cannot hear on account of the river.
pakaboóñgan ti ólo daytá	that is a matter for anxiety.
aniá ti dína pakabalinán	why cannot he do it?
isú ti pakapaneknekán	that is the proof.
sadíno ti nakatarayám	whither were you able to run?
nakasapúlak ditóy	I found it here.
aniá ti nakaariekánda	why did they sicken?
anía ti pakaturóganda	why do they become sleepy?
aniá ti pakainumànna manén	why does he want to drink again?
daytóy lakáy ti nakabasólak	I offended this old man.
aniá ti dína pakapagsañgítan	why can't he weep?
aniá ti saánda a nakapagsaoán	why couldn't they speak?
sadíno ti pakapagbaútam	where can you whip him?

3. *Maki* is *paki . . . an* (past: *naki . . . an*). Examples:

asín ti nakisaoám	to whom did you speak?
nakiasawáanna ni Juán	she married John.
aniá ti nakikuyóganyo kenkuána	why did you accompany him?
sadín ti pakiapáanna ken ína	where does she altercate with my mother?
isúda ti nakitallaóñgak	I joined them.
aniá ti nakitulágam kenkuána	why did you make a contract with him?
asíno ti pakianiányo	with whom do you harvest?
asíno ti nakidawátam ití tabáko	whom did you ask for tobacco?
sadíno ti pakisidaánda	where do they ask for viands?
isú ti pakikaiddaánna	he lies down with him.
isú ti nakikabbalayàk	I lived with him in the same house.
ditóy ti pakikatugawák ken kabsátko	here I sit down with my brother.

idiáy baláy ti nakibinnilánganda kenkuána	they counted it over with him in our house.
sadín ti pakibalanbalakádanda ken Juán	where do they give advice to John and get it?
pakipinnatenpategánmi kadakuáda ta agayanayátkami	we esteem them and we are esteemed by them because we love each other.
asín ti pakipagiddaám	with whom do you lie down?
sadíno ti nakipaginudoánna	where did he warm himself with them?
isú ti pakipaglak-ámanmi ití imbág	that is how we shall share in the good.
aniá ti nakipagsaritáanna	why did he talk with them?

4. *Mañg* is *pañg . . . an* (past: *nañg . . . an*). Examples:

sadín ti nañgaláam iti káyo	where did you take the wood?
adíno a balày ti nañgaldáwanda	in what house did they have lunch?
pañgababaán ti náganna	an abbreviation of his name.
awán ti pañgasáanyo	you have no hone.
sadín ti nañgroótanda	where did they gather grass?
ti karayán ti nañgipónanmi	we fished *ipon* in the river.
aniá ti namatiám kenkuána	why did you believe him?
ditóy ti pamantáyam ití págay	watch the rice here.
awán ti díak nañgsurátan	there is nobody to whom I did not write.
ti básolna ti panusáak kenkuána	I punish him for his faults.
ditóy ti panaritáanmi ití kayátmi	here we talk about what we like.
aniá ti nañgabílanda kenká	why did they beat you?
anià ti díka pañganán	why don't you eat?
aniá ti pañgapásanyo ditóy	why do you buy cotton here?

NOTE 16. When the original verb is formed with the simple infix *um*, ordinarily the combinations of some other adjectival prefix have to be used. However, there is a form of very little use, which it will be well to put down here: sometimes to indicate the place where, the reason why, the person in whose behalf something is done, the Iloko eliminate the infix *um* entirely and simply join the suffix *an* to the stem; this construction occurs mostly in the past form, which is made by the further addition of the infix *in*. In a few cases the infix *um* remains, and then the past form takes the infix *imm* instead of *in*. Examples:

aniá ti díka suñgbátan kaniák	why don't you answer me?
aniá ti sañgítanda	why do they weep?
aniá ti dída inulián	why did they not come up?
aniá ti saányo a tinugawán	why did you not sit down?
daytóy a baláy ti dinakkelánda	they grew up in this house.
adíno ti linabagáanna	where did it become red?
ti sakítko ti kinapúyak	I became weak on account of my illness.
idiáy ti linukmegánmi	we became fat there.
daytóy ti inayák	I came for this reason.
mumumuláak daytóy	I plant this.

ti sumpókan	the place where one enters the bushes.
aniá ti imminumánna ití gamút	why did he drink poison?
isú ti baláy a rimmuárak	that is the house from where I emerged.

C. The prefixes that indicate the manner how and the time when something is done have no special form for the past.

They are formed by changing:

1. *Ag* into *panag*. Examples:

intonanó ti panagsúratmo	when do you write?
kasanó ti panagdáitna	how does she sew?
intóno bigát ti panagdígusko	I shall take a bath to-morrow.
idí kalmán ti panagiddámi	we lay down yesterday.
nalaíñg ti panagsaóna	he talks fluently.
maipuón ití panagkarárag	by prayer.
nasayáat ti panagdániwna	she sings beautifully.
nalabés ti panaggaráwyo	you bustle too much.
kaanó ti panagságadda	when did they sweep it?
nakilló ti panagragádida	they saw crookedly.
kaanó ti panagsugálda	when did they gamble?
napalálo ti panagsúnay dagití ubbíñg.	the children play too much at spinning tops.
itáy ti panagbádok	I put on my coat just now.
itattá pay láeñg ti panagsapín ti anákko	my son wore pants for the first time.
kaanó ti panagkuritátayo	when do we gather cuttles?
nalabés ti panagalimbàsagko	I have the nightmare awfully.
nalabés ti panaguyékna	he coughs very much.
kastá la únay ti panagánus ni tátañgmo	your father is so exceedingly patient.
intonanó ti panagmáestrana	when will she be a teacher?
itáy malém ti panagkastána	he did so this afternoon.
idí panagkabannuágko	when I was at the height of my strength.
asidég ti panagkabagída	they are near relatives.
ti panagkainnay-áyo	coaxing one another.
nakabutbutéñg ti panagginnúra dagitá	those ones hate one another terribly.
nakaay-ayát ti panagtuloñgtúloñgyo	your helping one another is lovable.
saán a rumbéñg ti panaglallalákina	it does not fit her to dress like a man.
kitáem ti panagsiwaráda	look how they scatter.
ipáritmo ti panagtagilákona	forbid him to sell things.
kaanó ti panagintutúleñg ti anákko	when did my son simulate deafness?
nakakatkatáwa ti panaginsasáñgityo	your pretended weeping is ridiculous.
nasipútam ti panagkarasublína	did you notice its coming back all the time?

deñggém ti panagsanultípna	hear him blow a whistle with force.
makaúma ti panagranetrét ta rikép	the creaking of that door is tiresome.
kasanó ti panagbabtóogna	how does he knock noisily?
di sumardéñg ti panagkanaltóogda	they do not stop crepitating.

2. The infix *um* into the prefix *i*, with reduplication of the first open syllable of the stem. Examples:

itá ti isasañgpétko	I came home now.
kaanó ti yuúlina	when did he ascend?
kasanó ti yuúlogmi	how do we descend?
kaanó ti itatàona	when did he become man?
nadarás ti idadakkélna	he grew quickly.
nagináyad ti itatakdéryon	how slowly you rise.
intonanó ti ilalábasna	when shall he pass?
idí kalmán ti yaáyda	they came yesterday.
intóno rabíi ti isusublími	we shall come back this evening.
kasanó ti iseserrék dagití bábuy	how did the pigs enter?
itáy ti ibabáñgon ti anákko	my child arose just now.
napuótak ti iruruáryo	I noticed your coming out.

3. *Maka* and *ma* into *pannaka*. Examples:

kasanó ti pannakasañg-átmi	how can we ascend?
intonanó ti pannakaarámidmo ití baláy	when will you be able to make the house?
nalaús ti pannakabalínna	he has too much power.
intóno bigát ti pannakadánonmi	we shall be able to get there tomorrow.
napalálo ti pannakainúmko	I am very thirsty.
agduñgduñgsá gapó ití pannakatúrogna	he nods because he feels sleepy.
dakkél ti pannakabàsolna kaniák	he grievously offended me.
idí kalmán ti pannakalpásna	it was finished yesterday.
kaanó ti pannakaarámidna	when was it made?
itáy ti pannakasápulna	it was needed just now.
kasanó ti pannakaálana	how was it taken?
kaanó ti pannakapagkatáwana	when was he able to laugh?
kaanó ti dída pannakapagságad	when could they not sweep it?

4. *Maki* into *pannaki*. Examples:

kaanó ti pannakisaóm kenkuána	when did you talk with him?
intóno bigát ti pannakisarítak kenkuána	tomorrow I shall talk with him.
kasanó ti pannakikúyogko ken Tomás	how can I accompany Thomas?
naalás ti pannakiáñgawna kadagití balásañg	it is a shame to see him play with the girls.
idí pannakidáwatko kenká ití piràk	when I asked you for money.
makaúma ti pannakimamáda kadakamí	it is tiresome how they ask betel nuts from us.

narígat ti pannakigayyémyo kadakuáda	it is difficult for you to make friends with them.
nakaay-ayát ti pannakiamána ken gayyémko	it is lovable to see how he treats my friend as his father.
kaanó ti pannakikatugáwyo kaniák	when did you sit down with me?
idí napán a tawén ti pannakikabbaláymi kadagitá	last year we lived with those in the same house.
dakkél ti pannakiinnílìwmi	we long to see each other very much.
napaypaysó ti pannakipatenpatégko kadakuáda	my esteem for them and vice versa is true.
kaanó ti pannakipagkúyogtayo	when did we go together?
intonanó ti pannakipagtaráyna	when shall he run with them?

5. *Mañg* into *panañg*. Examples:

itáy it panañggátañgna ití kabáyo	he bought the horse just now.
awán ti panañginanàmamin	we have no more hope.
a las dos ti panañgaldáwmi	we had lunch at two o'clock.
kaanó ti panañgrabíiyo	when do you have supper?
intóno bigát ti panañgípontayo	tomorrow we shall fish *ipon*.
kaanó ti panañgróotmi	when do we gather grass?
kaanó ti panamarsuána ití lúbong	when did he create the world?
narambák ti panamonpónna ken amána	he buried his father solemnly.
idí panamakádam kaniák	when you took leave from me.
ti panamuggóna kadagití sákada	his washing their feet.
naimbág ti panamagbagá	advice is good.
ti pammatégko kenká	my esteem for you.
kasanó ti pannubbótna kadakayó	how did he save you?
kasanó ti pannaráonko kadagitóy	how must I feed these?
ti pammáti	the faith.
ti pannaksí	the testimony.
kaanó ti pannañgánmi	when do we eat?
kastóy ti pañgñgeddéñgmo	do you decide this way?

NOTE 17. In a good many localities the Iloko pronounce *panag*, *pannaka*, *pannaki*, and *panañg* in a different way: they change the first *a* into *i*, and pronounce: *pinag*, *pinnaka*, *pinnaki*, and *pinañg*, respectively. This may be the reason why some authors consider these last forms as those of a past tense; but this is entirely wrong, as these prefixes have no special form for the past, and the Iloko who pronounce *pinag* for *panag*, for example, use the same for both tenses. The correct forms *pinag*, and so on, are the past forms either of the instrumental prefixes *pag*, and so on, which have been explained under II, A, or of the combinations *pag . . . en*, and others, which will be studied later. (Verbs implying order or permission, II, B.)

III. Verbal substantives corresponding more or less to the English ones are formed in exactly the same way as the preceding forms in *panag*, and so on, with the simple addition of the suffix *an* to the stem. However, the form in *i*, derived from

the infix *um,* does not allow this combination. These verbal substantives have no special form for the past. Examples:

itá ti panagodóñgan	now is the time to go to the town (on a feast day, for example).
intóno panagsursúran	when they will go from house to house.
kaanó ti panagburásan iti otóñg	when is the time of gathering cow-peas?
itóy a búlan ti panagtináan	this month is the time for dyeing.
aluádanyo ti panaggaíkan	take care in weeding.
ti panagdaítan	the sewing.
rumañg-áy ti panagmulàan	agriculture progresses.
ti panagtalónan	working the rice fields.
intóno bigát ti panagsimpáan	tomorrow is the time of putting the last touch.
ti panagtaraknán	breeding.
no addá áñgol isú ti pannakatayán dagití tattáo	when cholera reigns many men die (literally: it is the time of the death of men).
intóno bigát ti pannakibuyáan	tomorrow is the show.
naládaw ti panañganán	the meals are late.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

An Ecological Glossary. Compiled by J. Richard Carpenter. Norman, Oklahoma, University of Oklahoma press, 1938. 306 pp., appendix. Price, $4.

This Glossary, in which definitions and concepts of ecological terms are stated in brief, clear, and concise language, is the most exhaustive and complete work on ecology that has ever been put in print. It was prepared primarily to reconcile the divergent meanings of many ecological terms, as given in past ecological literature, so as to conform with the recommendations of the Committee on Nomenclature of the Ecological Society of America.

While the author makes no pretense at calling the book complete, it includes nearly all technical ecological terms encountered in an exhaustive search of all available literature on the subject. Some 3,000 definitions of different terms used in ecology with various formulæ are lucidly presented in this treatise. For convenience the ecological terms have been arranged alphabetically.

Of special interest to students of ecology is the discussion on the "development of ecological nomenclature" which is a résumé of the history of ecology. A complete list of literature and a historical bibliography of all pertinent papers from 1895 to 1935, inclusive, dealing with terms and concepts of ecology, are included.

The appendix includes tables and maps showing different life zones of America and tables of biotic areas and equivalent terms used by present-day ecologists, which further simplify what the author desires to bring out in the main part of the book.

This book is a valuable reference not only to students who are interested in ecological literature but also to researchers in all biological sciences.—H. S. S.

Foods America Gave to the World. By A. Hyatt Verrill. Appendices in Collaboration with Otis W. Barrett. Boston, L. C. Page & Co., c1937. 289 pp., illus. Price, $3.

This book is a popular account of the known foods native or claimed to be native to the New World. The first twenty chapters are devoted to food plants, and the remaining two chapters to animal foods many of which are either little known or totally unknown in many parts of the world. Most of the important plants included are found and cultivated as major or minor crops in several countries, both in the East and in the West.

The first section includes a group of food plants from some species of the lowly weeds and ferns for their tender and nutritious shoots to the exalted family of the orchids from the pods or "beans" of which a vanilla scent for flavoring purposes can be extracted by highly complicated methods. Many of these plants grow in the wilderness of tropical America, and their edible products in most cases can be had for the picking. The author has taken time to trace briefly the origin and distribution of some of these plants outside of the Americas. He has especially noted down the rôle played by the American aborigines, the pre-Incas, the Incas, and the Aztecs, in the cultivation, improvement, and utilization of most of the better-known species. Each plant is adequately described and illustrated from the point of view of the layman. Many interesting and curious facts concerning them are recounted. The author has included helpful hints and precautions in the preparation of the edible products from otherwise unpalatable and poisonous plant materials.

In the last two chapters the author has enumerated several animals used as foods, a number of which are delicious to some people and far too odorous and repulsive to others. He deplores the reluctance and unwarranted prejudice of most people against many of these truly delicious foods. With increasing knowledge about them and the much improved storage and transportation facilities many of them are gradually being placed on the markets of the world.

A classified list of American foods, both plant and animal, with a brief note for each and in alphabetical arrangement under each class, is appended to the book. The book is very fascinating and enlightening throughout its pages. It should find a place in the public and school libraries.—Q. A. E.

Précis de Médecine Coloniale. By Ch. Joyeus and A. Sicé. Paris, Masson et Cie, 1937. 2d ed. 1,250 pp., illus. Price, 170 francs.

Following the former plan of grouping the exotic diseases according to the organs and systems involved, the second edition of the Precis is now available for practitioners interested in geographic medicine. An important innovation in this edition is the discussion of the epidemiology of infectious diseases immediately after the description of the causal agents.

The first part of the book describes the diseases of the digestive system and its adnexas. Starting with Engasgo's disease, common in the uncivilized interior parts of Brazil, which was recently studied and described by E. Vampré, the author gives a detailed and comprehensive presentation of the parasitic and diarrhæal diseases of the intestines, such as hymenolepis, ankylostomiasis, bilharziosis, distomatosis, amœbiasis, balantidiasis, giardiosis, cholera, and minor ailments. Bacillary and amœbic dysentery are described carefully and extensively. The exotic diseases of the liver and the other organs of the body are thoroughly dealt with.

The second part is devoted to the exotic febrile diseases. This general heading is divided into two subheadings, of which the first one comprises the exotic eruptive diseases, foremost among which are alastrim, smallpox, and the different form of typhus and exanthematous fevers, and the second includes the exotic icterogenous febrile diseases of which spirochætósis, icterohæmorhagica, billious hæmoglobinuria fever, malaria, recurrent fever, dengue, oroya and undulant fever, plague, kalaazar, chagas disease, and tularæmia, form a part.

The authors stresses the biology of the causative parasites, laboratory diagnosis, and external factors influencing the diseases. The most effective and up-to-date methods of treatment of each disease are described.

The third part is devoted to the general exotic diseases, among which are beriberi and poisoning and intoxication by venomous animals and insects.

The index at the end increases the usefulness and value of the book. The book is illustrated and contains references. It compares favorably with other publications on the same subjects and should prove very useful to the practitioner in the Philippines.—J. A.

An Enumeration of Plants Collected in Sumatra by W. N. and C. M. Bangham. By Elmer Drew Merrill. Contributions from the Arnold Arboretum of Harvard University, VIII. Jamaica Plains, Massachusetts, The Arnold Arboretum of Harvard University, 1934. 178 pp., illus. Price, $2.50.

To one interested in the Sumatran flora in particular, and in the Indo-Malayan in general, this paper is of great value. The enumeration is based on about 600 plants collected by Walter N. and Catherine M. Bangham in December, 1931, and in January and February, 1932, in northern Sumatra. The enumeration also included about 70 numbers of Orchidaceæ in the herbarium of Prof. Oakes Ames and 70 herbaceous plants presented by the Arnold Arboretum to the Gray Herbarium. The Bangham collection includes about 484 species, 105 of which are known only from Sumatra; 34 only from Java and Sumatra; 16 only from the Malay Peninsula and Sumatra; 6 only from Borneo and Sumatra; 10 only from the Malay Peninsula, Java and Sumatra; 110 only from Java, Borneo, and Sumatra; 9 only from the Malay Peninsula, Borneo, and Sumatra; and 15 only from the Malay Peninsula, Java, Borneo, and Sumatra. Thirteen additional species also have this last restricted range, except that they also extend to the Philippines. Nearly 217 of the 484 species are confined thus to the Sunda Islands and the Malay Peninsula, while most of the other species are much more widely distributed. In general the collections indicate an essential unity of the flora of the Sunda Islands (Java, Borneo, and Sumatra) and that of the Malay Peninsula. It is of interest to note that 25 of the species of the Bangham collection represent Asiatic types some of which are known outside of continental Asia only from Sumatra, and none of which are known from the Malay Peninsula, Borneo, or Java.

The collections represent 6 families of ferns, 2 families of gymnosperms, 11 families of the monocotyledons, and 80 families of dicotyledons. Thirty-eight are new species, the types being deposited in the herbarium of the Arnold Arboretum, with isotypes of most of them in the herbarium of the New York Botanical Garden.

Various changes in nomenclature have been found unavoidable by Doctor Merril. One of these is the adoption of the generic name *Poikilospermum* Zippell (1864) for *Conocephalus* Blume (1825), not of Necker (1790) as validated by Dumortier (1822), in the family Moraceæ, under which various new combinations were made.

The enumeration includes 38 new species distributed as follows: Ericaceæ, 7; Orchidacæ and Araliaceæ, 5 each; Anonaceæ, Myrcinaceæ, Primulaceæ, Gesneriaceæ, and Rubiaceæ, 2 each; and Moraceæ, Berberidaceæ, Saxifragaceæ, Rosaceæ, Meliaceæ, Euphorbiaceæ, Celastraceæ, Guttiferæ, Passifloraceæ, Apocynaceæ, and Labiatæ, 1 each. The species under the family Loranthaceæ were determined by Dr. B. H. Danser, of Groningen, Holland.

This contribution contains 14 plates. It is a valuable addition to the references in systematic botany.—J. B. J.

Sex Satisfaction and Happy Marriage. By the Reverend Alfred Henry Tyrer. Foreword by Robert L. Dickerson. New York, Emerson books, Inc., 1938. 160 pp., illus. Price, $2.

This book is a splendid piece of work, complete in every detail yet very concise in giving accurate information regarding sexual knowledge essential to normal happy marriage. While the author makes no pretense to embody in the book everything concerning sexual relationship and marriage, he has succeeded in presenting an unusual amount of well correlated data in a lucid manner understandable to the layman. In short, this book is a work that is scientific, comprehensive, and serious, yet human, brief, and simple.

In the first part the author presents factual details about the anatomy and physiology of the human sex organs. How and where babies are formed, and the course of pregnancy with emphasis on prenatal care, most particularly the preventive importance of intercourse, are briefly and interestingly dealt with. Abortion and birth control with their dangers are also succinctly but unsparingly discussed. Then simply, without malice but thoroughly, he discusses the behavior aspects of the "love play" and the "first nights," especially on the preventive value of the rapture of the marriage bond. Finally he touched on "many things" to which sex and marriage are closely and dependably related.

Dealing with most intimate and at the same time the most sacred relationship of the married couple, this book gives a straightforward approach to the subject. Even those people who consider taboo all sex impulses, manifestations, and consummations, will find the book wholesome, unprejudicial, and very beneficial to the body, to the mind, and to the soul. The book is worth a place on everyone's bookshelf.—S. A. E.

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The Cacao Industry of Trinidad. Some Economic Aspects. Series II, III, and IV. By C. Y. Shephard. Trinidad, Government printing office, 1936–37. 30+101 pp., illus.

General interest in the cacao industry of Trinidad and its economic aspects should increase as a result of the publication, in 1936 and 1937, of a series of three interesting articles; namely, a financial survey of estates during the seven years 1923–1930, an examination of the effects of soil type and age on yield, and recommendations for improving the efficiency of estates, all written by C. Y. Shephard, Carnegie Professor of Economics, Imperial College of Tropical Agriculture.

The author studied carefully the financial records of numerous cacao estates in all the principal cacao-growing districts in Trinidad and the results of the examination of fields of more important soil types with the object of ascertaining the principal factors responsible for the success and failure of these estates.

The author discusses the following subjects: Financial organization and management of estates, diversification of crops, housing, elimination of unprofitable cacao fields, selection of fields for treatment, advantages and disadvantages of replanting cacao fields, recognition and replacing of poor bearers, multiple-stemmed trees, types of planting material, care of supplies, method of rehabilitation, choice of fertilizers, subsequent treatment of fields, diseases and pests, and regeneration.

The most important factors that determine yield and profits in Trinidad cacao estates are unsuitable soil and the increasing age of the cacao trees. Under the conditions in which the estates were found, the outstanding suggestion made is to rehabilitate the cacao estates by a systematic and carefully designed plan with special attention to the elimination of unprofitable fields and concentration of effort on fields worthy of retention.

The author presents clearly and concisely to the students of the cacao industry various factors affecting the yield and profits and the means of improving the cacao estates. The most notable feature is the wealth of data and illustrations together with their unbiased interpretation.—P. A. D.

Sprinkle's Conversion Formulas. By Leland W. Sprinkle. Philadelphia, P. Blakiston's Sons & Co., Inc. 1938. 122 pp. Price, $1.25.

The conversion formulas in this little book are simple operations for changing one unit into another. As a whole the book

consists of condensed tables suitable for the everyday needs of professionals, businessmen, and housewives. To eliminate the personal equation as much as possible, the author uses only one simple process—multiplication. In this manner even school children who understand the four fundamentals of arithmetic can use the book to good advantage.

A busy person will find the tables helpful. With the help of this reference book students of chemistry, physics, and engineering will save time in the solution of problems. The alphabetical arrangement of units contributes greatly to the ease with which desired information can be found in this book.

—M. P. R.

Atlass of Hæmatology. By Edwin E. Osgood and Clarice M. Ashworth. San Francisco, J. W. Stacey, Inc., c1937. 255 pp., frontis., illus. Price, $10.

The profuse well-drawn illustrations in the text, showing vividly the cell structures, will never fail to make a lasting impression of the subject matter upon the mind of the reader. The systematic and concise way the structures and hæmatologic conditions are described, with close and frequent references to figures and tables, make the understanding and assimilation of hæmatologic facts quite simple. The text will be doubly useful to Filipino workers inasmuch as the illustrations are drawn from Wright-stained preparations, the stain more universally used in this country.

This atlas contains a classified list of references on hæmatology.—W. L.

The Principles of Cane Sugar Manufacture (together with a description of the machinery). By J. G. Davies. London, Norman Rodger, 1938. 144 pp., front., illus. Price, prepaid, 11s.

Although written for the nontechnical reader who possesses very little or no knowledge of cane-sugar manufacture, the book should have a place in the reference shelf of technical men as a guide in writing papers for laymen.

The author has endeavored to present the main branches of this great industry in a manner intelligible and interesting to the reader. This purpose was accomplished by the inclusion of flowsheets, graphic diagrams, and plates. The exposition is so clear and simple that the book will serve to help popularize science and industry.

The subjects discussed are: Juice extraction, steam generation, screening and clarification, subsidation (settling), filtration,

multiple-effect evaporation, crystallization, separation, processes for the manufacture of direct consumption sugars, fancy molasses, transport, the utilization of factory byproducts, and chemical control. The author mentioned new apparatus for sugar boiling but he failed to note the use of double helix crystallizers which are common in Philippine sugar centrals. To those looking for a general idea of the sugar industry, this book should be very helpful.—G. O. O.

The Soviet Food Industry; By A. I. Mikoyan. Moscow, Coöperative publishing society of foreign workers in the U. S. S. R., 1936. 77 pp. Price, 50 kopeks.

The solution of the food problem was regarded by the Soviet leaders as one of the most important tasks of National economic planning. While during the First Five Year Plan this task was left unsolved in favor of the more basic tasks of building the heavy industries and of solving the agrarian problem, with the Second Five Year Plan light industries and the food industries became all-important. Progress in these industries in comparison with both old Russia and foreign countries is reviewed in this book in terms of statistics.

Due mainly to the backward feudal character of her economy, tsarist Russia had no food industry except small-scale manufactures of vodka, sugar, and tobacco. By 1936, in less than 20 years after the Russian revolution, Soviet Russia has become the greatest producer of sugar in the world, having produced around 2.2 million tons, as compared to around 1.5 million tons by the United States exclusive of colonies. The Russian sugar refineries are linked with the sugar-beet fields by 2,300 kilometers of railway lines, and the Russians are now drying beet offal for cattle feed.

The Soviet Union holds second place in the fishing industry, second only to Japan and outstripping the United States, Great Britain, and Norway. She has 3,150 fishing vessels, with an aggregate of 230,000 H. P., and 26 cold storage plants. She has 55 fish canneries, with a total capacity of 252 million tins per year, and 28 plants producing fish oil and fish flour for cattle feed.

In the production of canned meat, fruits, vegetables, and milk, the Soviet Union has also improved tremendously, having produced in 1936 around 216 million tins of canned meat, 100 million tins of canned vegetables, 298 million tins of canned fruits, and 25.4 million tins of canned milk.

In animal industry rapid strides have also been made. Around 650,000 tons of meat, 170,000 tons of sausages, 285,000 tons of milk, and 193,000 tons of butter from 403 well-equipped mechanized butter factories, have been produced, although the production of cheese is still low.

As to vegetable oils, the Soviet Union's program for 1936 was around 475,000 tons, a low figure compared to the world's production. Production in this field is expected to improve after scientific improvements in the production of tea, citrus fruits, tobacco, essential oils, alcohol, rubber, and the like have been made. It is interesting to note that around 42,000 tons of synthetic rubber from alcohol and 5 million decaliters of 99.8 proof alcohol for airplanes and automobiles were produced in 1936, as factors in self-sufficiency.

Considering that all the basic means of production in the Soviet Union are socialized, these rapid strides not only in the basic industries but also in the light and food industries can mean only a higher standard of living for all people of that country.

This pamphlet summarizes much information of value to any one interested in the solution of the food problem.—V. G. L.

Floral Morphology; a New Outlook with Special Reference to the Interpretation of the Gynæceum. V. 1. By E. R. Saunders. Cambridge, W. Heffer & Sons, Ltd., 1937. 132 pp., illus. Price, 3s 6d.

The present volume is a résumé of a series of papers by the author on the subject of carpel morphology of angiosperms. It is intended primarily as a guide to the study of types for laboratory work. It contains an exposition of the general principles underlying the floral arrangement and data directly or indirectly relevant to his viewpoint, leaving the reader to look for other information from existing works on systematic botany. Thirty-nine families are considered. In each family the general characters of the flower and one or more 'illustrative' types are examined in detail.

Attention is mainly focused on the features and interrelations of floral members so as to give the reader a correct interpretation of the floral ground plan. A satisfactory solution of the problems of floral morphology, as given in this book, is not to be expected unless evidence of external appearance is supplemented by that of the internal, specially where union between floral members, whether of the same or different whorls usually peculiar to gynæceum, takes place. Particular families were

selected for consideration and examination from the standpoint of the problems presented by the particular types of construction, apart from systematic relationship, although so far as it could conveniently be done, groups of related families have been treated together. The book would have been more interesting to students of phylogeny if more extensive discussions on this subject had been added to the text.—J. B. J.

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OTTO SCHÖBL

By CIRILO B. PEREZ

Of the Scientific Library, Bureau of Science, Manila

ONE PLATE

Dr. Otto Schöbl, former Chief of the Division of Biology of the Bureau of Science, died in Tokyo, Japan, October 13, 1938, at the age of 61, following a brief illness. Doctor Schöbl was instrumental in the organization of the Bureau of Science laboratory for the large-scale manufacture of biological products. The members of his staff still point with pride to the accomplishments of this laboratory.

Doctor Schöbl was born in Zdice, Czechoslovakia, August 27, 1877. He received his M. D. degree in 1904 from the Government University of Prague, Austria. During his undergraduate years he was appointed assistant. After his graduation in medicine, Doctor Schöbl had three years of practical experience in bacteriology and pathology in Austria.

In 1907 he went to America, and from that time till 1911 he was employed by H. K. Mulford, manufacturing chemists, Philadelphia, one of the largest concerns of its kind in America. In this establishment he gained intimate knowledge of the manufacture of vaccines and sera. March 18, 1912, he accepted an appointment as pathologist in the Bureau of Science. He returned to the United States April 1, 1915. While in the United States, he resigned from the Bureau of Science and accepted a position in the New York State Quarantine Service where he continued the work he had begun in the Philippines on experimental cholera carriers. His return to the Bureau of Science in 1916 was very much appreciated by the Philippine Government on account of his years of experience and wide training in pathology and bacteriology. From 1916 until his

retirement in 1932 he was the Chief of the Serum Section, later known as the Division of Biology.

Doctor Schöbl arrived in the Philippines at the time when the Islands, facing the serious problems growing out of the ravages of tropical diseases, needed a man of his caliber and training. He threw himself wholeheartedly into the study of cholera, dysentery, smallpox, plague, and typhoid, turning his attention more and more to research on vaccines and immunity, studies in which he made notable contributions. The highly developed biological products prepared in the Bureau of Science are in a large measure the outward embodiment of the painstaking work of Doctor Schöbl. The researches of the Bureau of Science on tropical medicine and the improvement of biological products under Doctor Schöbl's supervision were mainly responsible for the eradication in the Philippines of epidemics like cholera, dysentery, typhoid, and smallpox.

Ageing, and his vitality undermined by hard, confined work, he was advised by his doctors to have a change of climate. Following his retirement in 1932 he went to Tokyo, the land of his adoption, and taught in several medical colleges. In 1934 he was decorated by the Japanese government with the order of the Rising Sun, fourth class, for investigations on frambœsia (yaws), carried on in the Philippines in collaboration with Japanese researchers. This honor is considered a rare distinction, for only few presidents of Japanese universities have received such an award even after 20 years of distinguished service to their government. Doctor Schöbl was accorded the distinct recognition which comes to a man of the highest scientific standing.

In 1918 Doctor Schöbl was elected president of the Manila Medical Society—a proof of the confidence of American and Filipino physicians in his integrity. For many years he was on the editorial board of the Philippine Journal of Science. In 1923 he served as a member of the Philippine Relief Mission to Japan. His work on this Mission was highly commended, as shown by the following letter:

Aboard the U. S. A. T. "Somme"
October 22, 1923

The Director,
Bureau of Science,
Manila, P. I.

SIR:

I desire to make of record the very valuable services rendered by Dr. Otto Schöbl, of the Bureau of Science, as a member of the Relief Mission

from the Philippines which recently brought assistance to the devastated areas of Japan.

Doctor Schöbl has at all times been most willing and efficient. He has volunteered for unfamiliar duties and has carried them out with the same fidelity and success that characterizes his professional work in your Bureau. Of attractive personality, he has endeared himself to all members of the Relief Mission. His knowledge of Japan and of the Japanese language has made his advice and services as interpreter of very great value.

I desire to invite favorable consideration of Doctor Schöbl's services, as above, and request that this letter, which has been prepared without his knowledge, be filed with his official record.

Very respectfully,

(SGD.) E. L. MUNSON
Colonel, Medical Corps, U. S. A.
Chief Surgeon, Japan Relief Mission.

Doctor Schöbl's position in the scientific world rests on his work done in the Bureau of Science, some of it in collaboration with his assistants. He made for himself and for the Bureau of Science an enduring reputation in the fields of bacteriology and pathology. An examination of his writings reveals plainly his versatility and scholarly presentation of his subjects, of which the most important are yaws, syphilis, leprosy, rat-bite fever, cholera, dysentery, and typhoid. He wrote 84 articles published in several journals, chiefly in the Philippine Journal of Science. His knowledge of the English, Spanish, German, Japanese, and Czech languages made his services of great value.

Doctor Schöbl had the universal respect and admiration of all who knew him. One always recognized in him the painstaking devotion to duty, simplicity, and quiet sincerity which are traditionally attributed to a true scientist. Doctor Schöbl is dead, but his accomplishments stand clearly recorded in the annals of science and in the memories of his colleagues. Several countries will feel proud of the scientific heritage that Doctor Schöbl left. He was born and raised in Czechoslovakia, educated in Austria, engaged in research work in the United States and for the Philippine Government for almost 20 years, and died a Japanese citizen.

Doctor Schöbl is survived by his Japanese wife and an adopted son.

On the occasion of Doctor Schöbl's death, Dr. Eduardo Quisumbing, then Acting Director of the Bureau of Science, paid the following tribute:

Doctor Schöbl's colleagues in the Bureau of Science are very sorry to learn of his death. Considering the inestimable value of his researches

on tropical medicine and the significance of the biological products which were improved under his supervision and which are mainly responsible for the eradication of epidemics, such as cholera, dysentery, smallpox, and typhoid, Doctor Schöbl's passing is a great loss to the Philippines in particular and to the scientific world in general.

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ILLUSTRATIONS

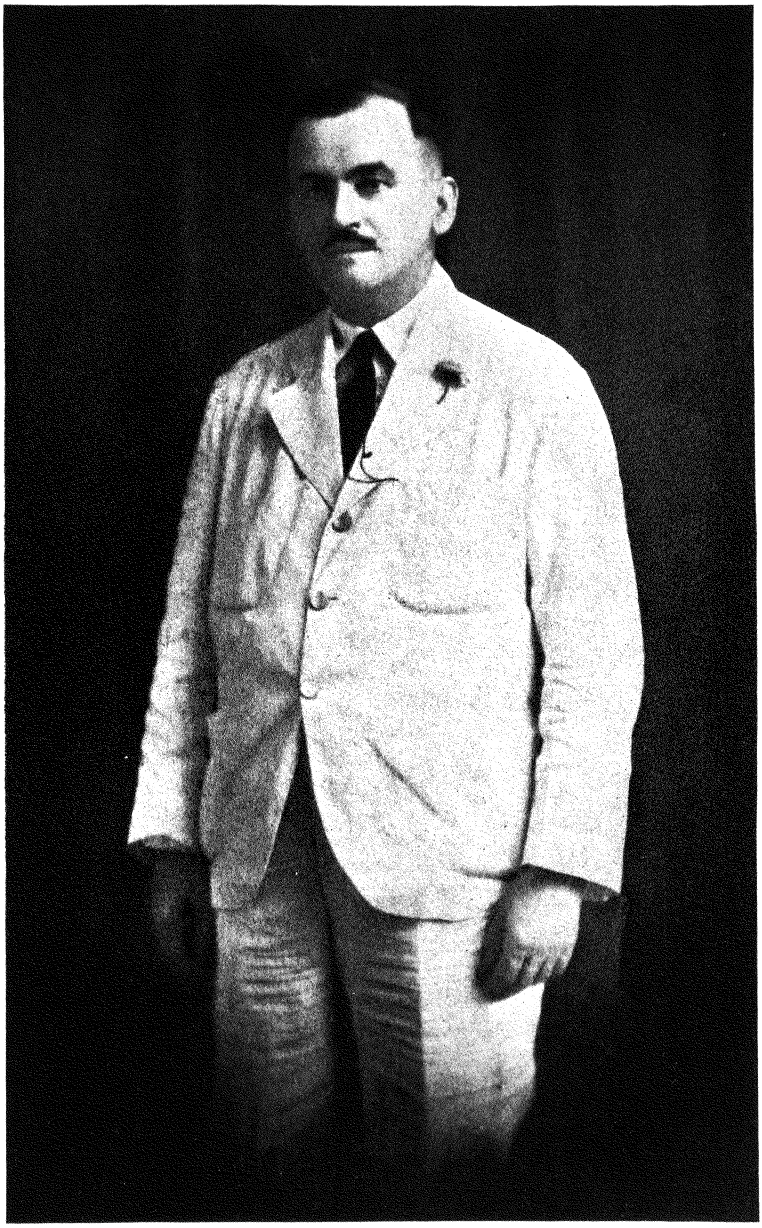

PLATE 1. OTTO SCHOBL

GENESIS AND MORPHOLOGY OF THE SANDY SOILS OF PAMPANGA AND TARLAC PROVINCES, PHILIPPINES

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THREE PLATES

The region comprising Pampanga and Tarlac Provinces, where this investigation was conducted, is a part of the Great Central Plain of Luzon. During the soil survey of these provinces, made in the dry season of 1936, a large area of sandy soils was found, classified, and mapped. This area covers almost one-half of the total area of the two provinces, which is about 518,210 hectares. A great portion of the level land, a total area of approximately 214,765 hectares, extending from the town of San Fernando to the town of Paniqui, a distance of about 85 kilometers, is sandy soil. Sugar cane is the most important crop in this type of soil, Pampanga and Tarlac Provinces deriving most of their income from this crop. The rice crop, next in importance, is grown exclusively in clay-loam soils. Minor crops grown in these sandy soils are peanuts, sweet potatoes, and pineapples and other fruits. Vegetables of various kinds and citrus fruits are quite common in these sandy soils.

The soils as a whole have never been studied. In the opinion of the author a rational approach to the problems of the productivity of these soils involves pedalogical knowledge. It is the object of this investigation to study the origin and the nature or mode of formation of this soil as a whole.

ENVIRONMENTAL FACTORS

Climate.—As in the other provinces of the Great Central plain of Luzon, the climate of Pampanga and Tarlac Provinces consists of alternating wet and dry seasons: wet during the summer and autumn months and dry during the winter and spring months. Heavy rainfall occurs during the latter part of spring until the middle of autumn. The dry season begins during the latter part of autumn and lasts until the middle of spring. The temperature is high and almost constant throughout the year,

except during November, December, and January. The climatic records, including mean annual rainful and temperature of San Fernando and Tarlac towns, are given in Table 1.

TABLE 1.—*Average monthly rainfall and temperature of San Fernando, Pampanga Province, and Tarlac, Tarlac Province.*

Month.	San Fernando.			Tarlac.		
	Rainfall 1925–1932.	Temperature, 1925–1931.		Rainfall, 1925–1932.	Temperature, 1925–1931.	
		Maximum.	Minimum.		Maximum.	Minimum.
	mm.	°*C.*	°*C.*	*mm.*	°*C.*	°*C.*
January	20.8	31.3	19.9	6.7	31.5	19.2
February	11.4	32.2	20.2	10.8	32.5	19.9
March	20.8	33.9	21.1	21.2	33.6	20.9
April	51.9	35.0	22.9	72.1	35.1	22.3
May	215.4	34.3	23.8	215.8	33.6	23.1
June	306.0	32.1	23.9	315.8	31.7	23.3
July	369.3	31.9	23.5	366.5	31.1	23.2
August	362.4	31.2	23.6	409.7	30.9	23.0
September	250.5	31.8	23.5	222.2	31.8	22.8
October	155.6	31.9	22.9	135.5	32.1	22.3
November	75.4	31.2	21.8	40.3	32.0	20.9
December	30.3	30.9	20.3	12.7	31.0	19.0
Mean annual	1,869.8			1,829.3		

Vegetation.—The entire sandy region was once under forest. Today, however, few trees are found, mostly along the foothills and river sides. Woodland savannah is also found along the rolling area below the foothills. Trees scattered here and there include *alibangbang, Bauhinia malabarica* Roxb.; *camachile, Pithecolobium dulce* (Roxb.) Benth.; and *duhat, Eugenia jambolana* Lam. Several bamboos, *Bambusa vulgaris* Schrad. and *Bambusa blumeana* Schultes, and *boho, Schyzostachyum lumampao* (Blanco) Merr., are growing along the rivers and creeks. Grasses like *cogon, Imperata cylindrica* Linn.; *talahib, Saccharum spontaneum* Linn., and *aguingay, Imperata exaltata* Linn., are found in uncultivated areas.

Physiography and geology.—The region is nearly level to gently rolling on the eastern side, and hilly and rolling on the western side. In the lowlands of Pampanga Province the elevation at San Fernando is 20 feet above sea level, gradually increasing to 300 feet at Mabalacat town, decreasing again toward the towns of Bamban, Concepcion, and Capaz, finally dropping to 40 feet above sea level at Paniqui and Moncada towns. The rise and fall in elevation is so gradual as to be hardly perceptible.

The most important rivers of this region are the Pasig, Gumain, and Bamban Rivers of Pampanga Province and the O'Donnell and Tarlac Rivers of Tarlac Province. These rivers control the drainage system of this sandy region.

The geologic map of the Philippines shows that the Great Central Plain consists of piedmont, spring talus, laterites, river deposits and coral reefs. The eastern flank of the Zambales range consists of tertiary and later effusive rocks (rhyolites, dacites, andesites, and basalts). Below this flank is a narrow strip of tuffaceus area.

The sandy area under investigation consists mostly of river deposits of freshly weathered rock material which originated from the eastern flank of the Zambales range. The narrow strip of tuffaceous area is practically covered by these sediments. The rocks from which these sediments were derived consist of andesites, mostly feldspathic andesite porphyry and hornblende, and feldspathic andesite porphyry (Plate 2).

MORPHOLOGY

Soil series and types.—During the soil survey of Pampanga and Tarlac Provinces three series of sandy soils were established and mapped. The Angeles and La Paz series are found both in Pampanga and Tarlac Provinces, while the Luisita series is found only in Tarlac Province. A study of the different soil profiles of these three series reveals similarity in soil formation. The variation in the depth of various horizons, coarseness in texture, color, structure, and consistency are due largely to the elevation, topography, and drainage of the area. The surface soil of the undisturbed area is more compact than the surface soil of the cultivated area.

The Angeles series has a pale brownish-gray, pale or ash-gray, to nearly whitish-gray surface soil. The subsoil is brownish-gray to light reddish-brown sand containing gravel. The substratum is sand to coarse sand containing gravel and sandstones. There are four types in this series; namely, coarse sand, sand, fine sand, and sandy loam. The La Paz series consists of fine sand in the subsoil, similar to the Angeles series. The substratum consists of medium to fine sand without gravel. There are two types in the series; namely, fine sand and fine sandy loam. The Luisita series consists of coarse sand in the subsoil and coarse sand containing soft tuffaceous concretions and gravel in the substratum. There are three types of soil; namely, fine sand, sandy loam, and fine sandy loam.

Profile characteristics.—Several soil profiles of the three series of the sandy soils were studied. The morphological characteristics of one representative type of each series will be presented.

The fine sandy type of the Angeles series occupies a wide area in Pampanga. A typical profile of this type obtained at barrio Dolores, Mabalacat town, shows the morphological characteristics of the different horizons.

ANGELES FINE SAND

Depth of soil. cm.	Characteristics.
0 to 30	Pale brownish-gray, loose, and structureless fine sand; decayed roots and leaves present; pH, 6.77.
30 to 50	Brown to light reddish-brown medium sand with sandstones and gravel; decayed roots and leaves present; pH, 6.55.
50 to 75	Mixture of pale-gray to nearly white sand and reddish-brown gravel; decayed roots of trees present; pH, 6.44.
75 to 95	Same as above but with more gravel; no roots; pH, 6.44.
95 to 110	Gray coarse to medium sand, structureless; sand resembling silica present; pH, 6.30.
110 to 150	Sandstone, grayish white, coarse, and gritty; pH, 6.30.

The mechanical analyses of the profile samples of this type are shown in Table 2.

TABLE 2.—*Mechanical analyses of the profile of Angeles fine sand.*

Depth of horizon.	Coarse sand, 0.2-0.22 mm.	Medium sand, 0.22-14 mm.	Fine sand, 0.14-0.07 mm.	Very fine sand, 0.07-0.05 mm.	Silt and clay, 0.05 mm.
cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0- 30	47.3	16.5	11.9	6.2	18.1
30- 50	52.2	16.3	8.5	12.0	11.0
50- 75	64.8	19.2	5.5	7.2	3.3
75- 95	68.8	15.6	5.0	3.6	7.0
95-110	66.8	15.7	6.2	5.0	6.3
110-150	60.8	21.0	6.5	4.8	6.9

Except for the texture of the surface soils, the analyses of the samples of the other types of the Angeles series show fundamental similarity to the profile samples of the fine sand type.

The La Paz series is represented by the La Paz sandy loam type. It was established in the vicinity of barrio La Paz between the towns of San Fernando and Angeles. This type is also found in Tarlac Province. The profile of La Paz fine sandy loam obtained at Barrio Salomagui, town of Paniqui, shows the following characteristics:

LA PAZ SERIES

Depth of soil. cm.	Characteristics.
0– 50	Light gray to gray fine sandy loam, structureless and slightly compact; pH, 6.55.
50–110	Grayish-brown to yellowish-brown fine sand, cloddy to nutty in structure; pH, 6.19.
110–150	Brownish-gray to brown coarse sand, loose and wet; zone of water table; pH, 6.27.

The mechanical analyses of these profile samples are shown in Table 3.

TABLE 3.—*Mechanical analyses of the profile of La Paz fine sandy loam type.*

Depth of horizon.	Coarse sand, 0.2–0.22 mm.	Medium sand, 0.22–0.14 mm.	Fine sand, 0.14–0.07 mm.	Very fine sand, 0.07–0.05 mm.	Silt and clay, 0.05 mm.
cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0– 50	1.6	12.3	13.4	21.0	51.8
50–110	1.0	2.0	18.6	35.5	42.9
110–150	0	23.0	36.3	19.0	21.7

The Luisita series was established and mapped within the vicinity of Hacienda Luisita, Tarlac Province. The soils with no irrigation are mostly utilized for sugar cane, while the areas with irrigation are planted to rice. The profile of the Luisita sandy loam was obtained within Hacienda Luisita.

LUISITA SANDY LOAM

Depth of soil. cm.	Characteristics.
0– 40	Brownish-gray to gray, loose and structureless sandy loam; pH, 6.46.
40– 80	Brownish-gray coarse sand with small amount of clay; almost compact; pH, 6.24.
80–150	Coarse sand with tuffaceous concretions and gravel; loose and coarse, granular; pH, 6.19.

The mechanical analyses of the profile samples are shown in Table 4.

TABLE 4.—*Mechanical analyses of the profile of Luisita sandy loam type.*

Depth of horizon.	Coarse sand, 0.2–0.22 mm.	Medium sand, 0.22–0.14 mm.	Fine sand, 0.14–0.07 mm.	Very fine sand, 0.07–0.05 mm.	Silt and clay, 0.05 mm.
cm.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0– 40	22.0	18.5	10.3	13.0	36.2
40– 80	50.7	13.7	7.2	7.0	21.4
80–150	62.7	8.9	5.5	4.4	19.5

The other types of the Luisita series show similar horizons, although the mechanical analyses of the samples vary slightly from one another.

GENESIS OF THE SANDY SOILS

GENERAL DISCUSSION

The evolution of the complex constitution and habitus or general appearance of the soil body in relation to the natural laws responsible for its origin is known as soil genesis. It is controlled by a series of natural forces guided by definite natural laws which find expression through the factors known as "soil formers".(7)

Kellogg in his discussion on the factors of soil genesis gave the following equations responsible for the development of soil:

$$\text{Soil} = \int \text{Climate, vegetation, relief, age, and parent material.}^{(9)}$$

Shaw,(12) discussing the potent factors in soil formation, gave a similar formula, according to which the soil is formed from the parent material by climatic factors and vegetation through time. Shaw pointed out that the character of the parent material, its composition, density, and the rate at which it may be modified by the influence of climate and vegetation, has a persistent effect in determining the character of the resulting soil.

The sandy region of Pampanga and Tarlac Provinces may be considered as a constructive process of sedimentation. The practically exposed condition of the eastern flank of the Zambales Range bordering Tarlac and Pampanga Provinces, which is at the mercy of a warm and humid climate, makes for the exceptionally rapid weathering of the andesitic rocks. The torrential nature of the summer rains removes the deconsolidated materials as fast as they are weathered. These materials are brought down by the torrential and intermittent streams and deposited in the plain as the water loses its carrying power. It appears, however, that the foundation has been subsiding at about the rate of accumulation so that the surface of the deposition has maintained nearly the same level.(13) Such great amounts of fresh material, consisting mostly of sand, silt, and a significant amount of clay, are considered in a strict sense as parent material upon which the soil will develop.

The development of this material into a mature soil depends upon the factors or soil formers mentioned in the first part of this discussion. Under the influence of climate, vegetation, relief, and time this material will reach a stage where a soil will be formed. At this stage the surface or "A" horizon and the

subsoil or "B" horizon will be differentiated from the parent material. This formation, however, requires considerable time. In the initial stage of its development the characteristics of the soil are inherited from the parent material.

The three series of sandy soils of these provinces consist mostly of sandy material from the surface down to a depth of more than three meters. There is no differentiation between the surface or "A" horizon and the subsoil or "B" horizon. The most important characteristics of the profile include the characteristics of the sandy material consisting of weathered andesitic rock, which is also the parent material of the developing soil. Thus the sandy soil is in the early stage of development and may be considered young soil. The presence of decayed plant residue in the surface soil is part of the work of vegetation and climate. Continuous cultivation of the area disturbs the development of the soil. The leaching of the different salts and other plant-food elements to the substratum is unchecked during the rainy season, because there is no hardpan or fine material accumulation in the lower portion of the profile. During the dry season, however, these substances are brought up again by means of excessive capillary action and evaporation.

In wet areas the excess water during the rainy season flows readily, carrying with it whatever loose fine material is on the surface. Thus the development of these soils is always affected by the erosion of the surface soil. In areas where there is a continuous vegetative cover, the development may proceed until otherwise disturbed by cultivation.

SUMMARY

The morphologic features of the three series of sandy soils of Pampanga and Tarlac Provinces show similarity in profile constitution, pH value, color, and structural arrangement. The sandy soils of the region are in the younger stage of soil development, showing no marked formation of surface or "A" horizon and subsoil or "B" horizon. Due to the structural formation of the profile, leaching is excessive and detrimental during the rainy season. However, there is excellent capillary action during the dry season. The development of the sandy soils resulting from the parent material of recent alluvial deposition of weathered andesitic rock, located on the eastern flank of the Zambales range, is the mode of soil formation.

ACKNOWLEDGMENT

The author is indebted to Dr. M. M. Alicante for his valuable suggestions during the course of the investigation, to Mr. Hernandez for help in the field, and to Mr. Marfori for pH determinations. These men are all members of the staff of the Soil-Survey Project of the Department of Agriculture and Commerce.

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ILLUSTRATIONS

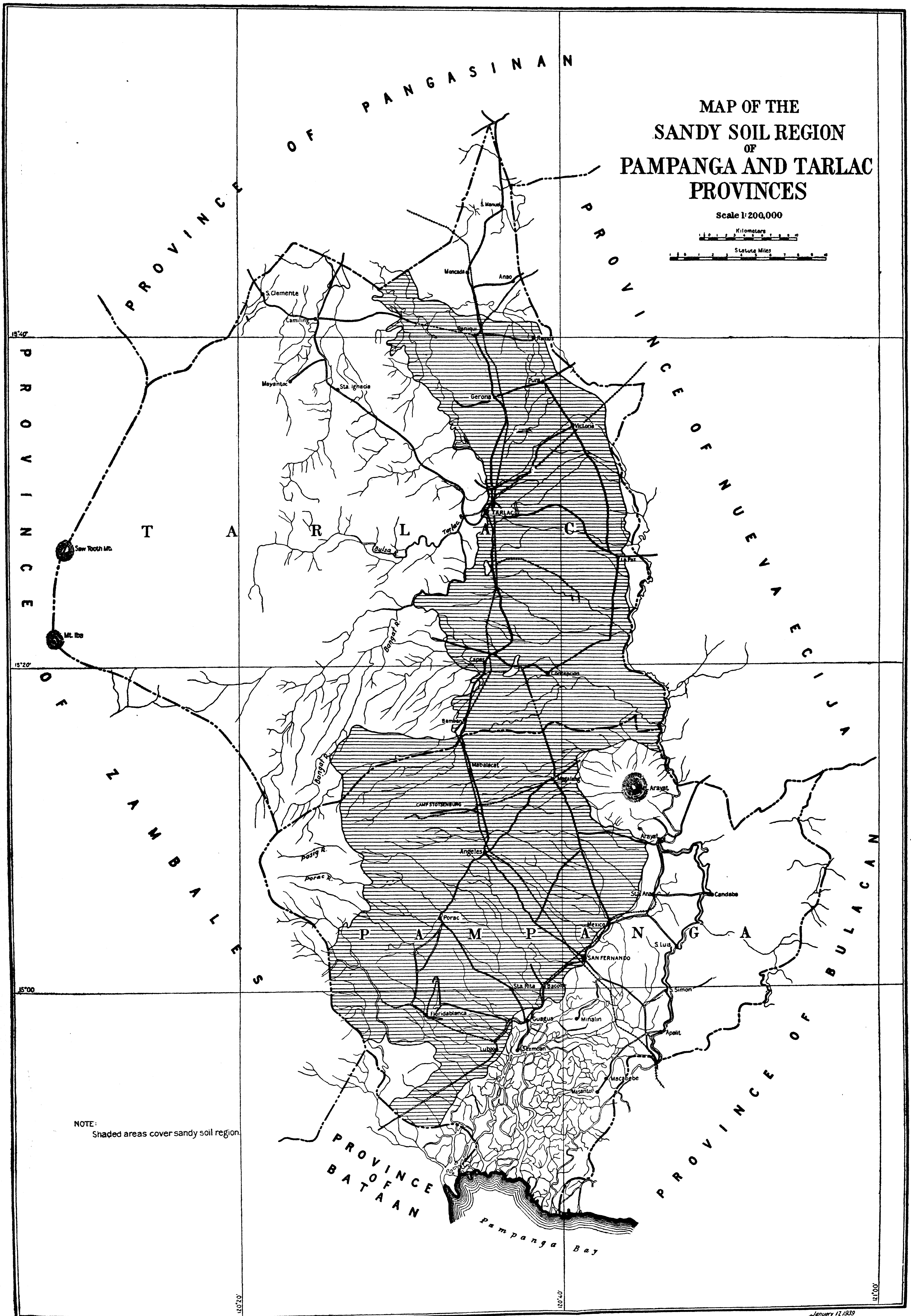


PLATE 1. LOCATION AND EXTENT OF THE SANDY REGION WITHIN PAMPANGA AND TARLAC PROVINCES.

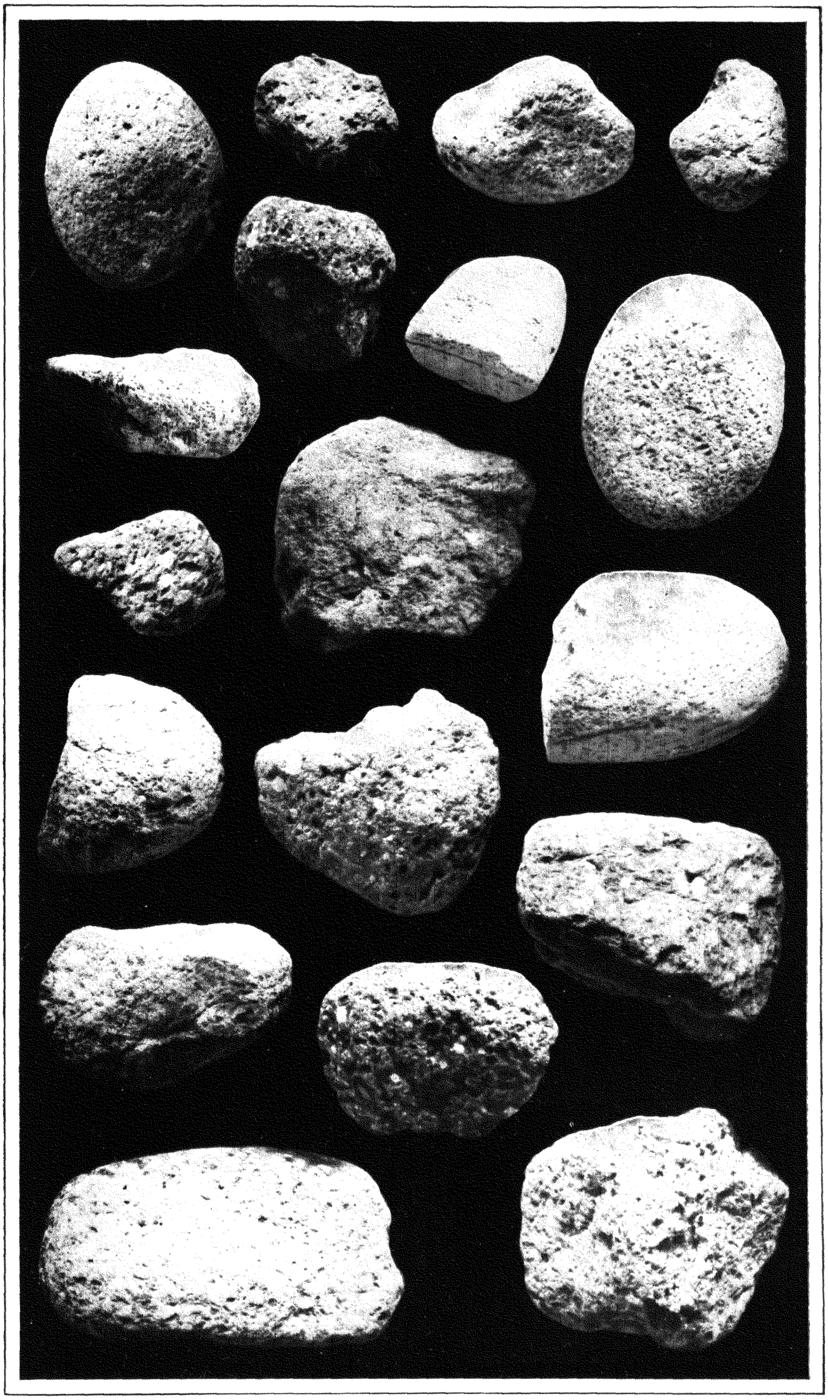
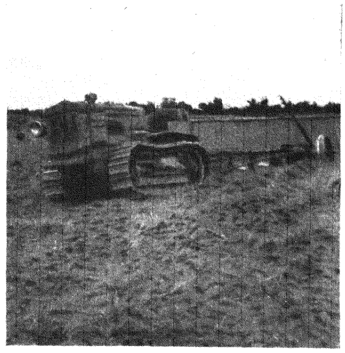


PLATE 2.

1



2

3

4

PLATE 3.

AN INTERPRETATION OF EUPHORBIA EDULIS LOUREIRO

By Leon Croizat

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Jamaica Plain, Massachusetts

Loureiro published *E. edulis* [1] with the following main diagnosis:

> *Caulis* fruticosus, 6-pedalis, 5-angularis, aculeis geminatis: *ramis* ascendentibus. Folia multa sparsa, sub-cuneiformis, apice rotundata, 3-pollicaria, integerrima, carnosa, glabra. *Corolla* nulla. Calyx 1-phyllus, carnosus, ventricosus, interius ruber, exterius viridis. *Stamina* brevia, 40 circiter. *Capsula* 3-cocca.
>
> Habitat culta in hortis Cochinchinae, puto, quod etiam agrestis.
>
> Usus. Folia elixa cum oleribus comedunt saepe indigenae absque noxa.

From its description *E. edulis* agrees with *E. neriifolia* except for the form of the leaf and the color of the cyathium. It is not *E. nudicaulis,* which Perrotet reported without collecting [2] from the vicinity of Surabaja, Java. Despite its "fleurs rouges" this very questionable spurge cannot be *E. edulis,* because it is described as having long, unarmed, and flexible branches. Nor are *E. neriifolia chinensis* and *E. varians* compatible with *E. edulis* from the descriptions that Haworth gives [3] of them. Inasmuch as the Loureiran diagnosis is the only record of the species, and the type is not extant, *E. edulis* has been considered doubtful or has been reduced with some justification to a synonym or variety of *E. neriifolia.* Merrill urges further investigation and diligent collection; [4] Gagnepain [5] and Boissier [6] believe that *E. edulis* may prove to be a form or a synonym of *E. neriifolia,* though the latter unaccountably misquotes Loureiro to the effect that *E. edulis* has diffuse branches, small leaves, and solitary flowers.

[1] Fl. Cochin. 1 (1790) 298.
[2] Mém. Soc. Linn. 3 (1825) 110.
[3] Syn. Pl. Succ. (1812) 130.
[4] Comm. Fl. Cochin. Proc. Am. Phil. Soc. (2) 24 (1935) 242.
[5] Lecomte, Fl. Gén. Indo-Ch. 5 (1915) 254.
[6] DC. Prodr. (2) 15 (1862) 80.

Loureiro sometimes adapted his diagnoses from Chinese sources or described plants from memory,[7] but it is almost certain that in this case he wrote the account of *E. edulis* with a specimen before him. The less credible of his statements, that the natives use the leaves of *E. edulis* as pot herbs, finds confirmation in the report of a modern collector,[8] who avers that in the Indian desert, at Jodhpur and Jaisalmer, the leaves of *E. neriifolia* are known as "papri" and eaten. From the somewhat confused account of Rumphius [9] it is learned that the leaves of species allied to *E. neriifolia* have a place in the diet of the natives of the Sunda Islands. De Candolle [10] is evidently compiling from Rumphius when stating "Les Éthiopiens [11] mangent les feuilles broyées comme remède contre les obstructions et les coliques." Not less than four spurges, namely, *E. neriifolia, E. Barnhartii* (*E. trigona* Roxb. *non* Haw.), *E. antiquorum* and *E. pulcherrima* are reported by Burkill [12] as edible in various degrees and as actually being made into sweetmeats by Chinese and Malayans. Additional references in the literature can be found to substantiate Loureiro's assertion, and the legitimacy which the specific name *edulis* gives to a *Euphorbia* of this description. The note "stamina 40 circiter" could not have been suggested to Loureiro otherwise than from the study of actual specimens. What, short of actual dissection, revealed to Loureiro that a species of the Dodecandria Trigynia had about three times as many "stamens" as are required by the Linnæan class definition?

Copious evidence from another quarter corroborates Loureiro's reports. A spurge resembling *E. neriifolia* but having a partly red cyathium was cultivated between 1772 and 1824 in public and private gardens of Italy, France, and England.

[7] Merrill, op. cit., 40.

[8] Macadam, in Journ. Bomb. Nat. Hist. Soc. 26 (1920) 970.

[9] Herb. Amb. 4 (1743) 90, 91.

[10] Hist. Pl. Gr. (1799) *pl. 46 cum text.*

[11] Rumphius speaks of *Æthiopes Hitoenses* (op. cit., 90) which manifestly were representatives of the Papuan negroid race variously known as Ahita, Aeta, Attas [Beccari, Nov. Guin. (1924) 437, footnote; Rep. Philip. Comm. 1 (1900) 13]. No reference to *E. neriifolia* is found in De Candolle's work that deals with medicinal plants [Ess. Prop. Méd. Pl. (1816)) 260-265], which further indicates that De Candolle merely compiled his data from Rumphius.

[12] Dict. Econ. Prod. Mal. Pen. (1935) 979-982.

Bonelli [13] illustrated crudely but quite effectively a plant of this description. De Candolle,[14] availing himself of the expert services of Redouté, gave of the same plant a fine likeness. Lamarck, Persoon, Haworth, and Colla knew this plant and apparently no other of its affinity. Lamarck [15] described its cyathium "vert dunâtre mêlé d'un peu de pourpre." Persoon [16] concisely stated that its flowers are red. Haworth,[17] as it seems, deliberately, overlooked the illustrations of Rheede, Plukenet, Commelin, and Bradley, and only referred to the plate of Redouté. Colla [18] also referred to Redouté's illustration. With the exception of Bonelli, who usually does not use Linnæan binomials, all the botanists cited reduced this red-glanded spurge to *E. neriifolia,* though it manifestly agrees neither with the *Ela Calli* of Rheede [19] nor with the *Tithymalus* of Commelin,[20] which are cited by Linnæus [21] in the publication of *E. neriifolia.* De Candolle [22] very nearly discovered that this red-glanded spurge was not the *E. neriifolia* of Linnæus, when he noted that Commelin's *Tithymalus indicus arborescens nerii folio* had long-peduncled cymes, not the subsessile inflorescence of the specimen figured by Redouté.

So far as I can learn the red-glanded spurge resembling *E. neriifolia* first appeared in cultivation in the botanical garden at Rome, a rooted section of stem in flower having been illustrated in 1772. It is significant that this plant was first noticed at the time when Loureiro was busy in his Indochinese apostolate and Maratti, Bonelli, and Sabati were zealously striving to refloat, with the papal blessing, the nearly shipwrecked Orto Romano. Sabbati [23] in particular is represented as very much interested in exotic plants, and had at least five succulent spurges in cultivation despite the fact that the Roman garden lacked hothouse facilities. Though Loureiro evidently preferred to transact his botanic affairs with British followers of the binomial system of classification, his duty as a missionary called for his maintaining continuous contact with Rome, and it is not unlikely that he obliged, with some token, the foremost Roman

[13] Hort. Rom. 15 (1772) *pl. 28.*
[14] Loc. cit.
[15] Enc. Méth. 2 (1786) 415.
[16] Syn. Pl. 2 (1806) 11.
[17] Syn. Pl. Succ. (1812) 130.
[18] Hort. Rip. (1824) 54.
[19] Hort. Malab. 2 (1679) 83, *pl. 42.*
[20] Pl. Rar. Hort. Amstel. 1 (1697) 25.
[21] Sp. Pl. 1 (1753) 451.
[22] Loc. cit.
[23] Hort. Rom. (1772) 8.

botanists of the day. Instances are on record [24] suggesting that the unknown type of a succulent spurge is probably the parent stock of cultivated plants the origins of which are unrecorded. It is well known that early botanists seldom took care to prepare succulent spurges for the herbarium and mostly relied upon live specimens and drawings to typify the binomials. In view of this fact it is reasonable to accept the illustrations of Bonelli and De Candolle as representing typical *E. edulis* Lour. This iconography disagrees with the description of *E. edulis* only in one detail; Loureiro describes a cyathium that has green nectaria (glands) and red lobes, whereas Bonelli and Redouté in their illustrations show that the reverse is true. The discrepancy does not exceed the limits of excusable error, due either to a misprint or to a slip of memory. In my mind Loureiro's binomial must be honored despite the incorrectly recorded sequence of the colors of the cyathium in the original publication of *E. edulis.*

Though unrecognized as such, *E. edulis* is being extensively cultivated throughout the world and is known to most amateurs of succulent plants. For at least forty years it has been grown in the Orto Botanico at Palermo [25] under the misapplied binomial, *E. laurifolia* Lam., which I have been able to ascertain from live material kindly furnished by Prof. D. Lanza, of the staff of that institution. From several correspondents it was sent to me from America, Europe, and Africa, mostly mislabelled *E. neriifolia.* I have never received it from India, however. Recently Prof. F. P. Metcalf, of Lingnan University, found *E. edulis* thriving in the neighborhood of Canton, China. The evidence does not seem to be far from conclusive that Loureiro described a well-known plant and possibly introduced it into cultivation in Europe; that this plant is cultivated throughout the world to this very time; that it occurs in southern China; that, if found in India, it is probably not common there. It may be suspected that *E. edulis* still thrives "in hortis Cochinchinae" because Gagnepain [26] describes a species with subsessile or sessile cyme that hardly is *E. neriifolia.*

Next to nothing is known today of the geographic distribution of *E. edulis.* It probably has the status of a purely southern

[24] Croizat in Bull. Jard. Bot. 15 (1938) 115, footnote 1.
[25] Bull. Ort. Bot. Paler. app. 3 2 (1898) xviii.
[26] Lecomte, Fl. Gén. Indo-Ch. 5 (1915) 240.

Chinese and Indochinese endemic which has achieved nearly pantropic distribution as an ornamental plant. It might on the other hand be found also native to Siam, Burma, and the Philippines. Good material is needed to define the issue and the weight of general evidence suggests that either distributional hypothesis is possible.

Broadly speaking, *E. edulis* is a mutation of *E. neriifolia.* Mutational aggregates are common in *Euphorbia* and often an amazing number of "petites espèces," to use the apt French definition, group themselves around a main form which taxonomists must recognize as the oldest one validly published. The study of such groups can seldom be adequately conducted without an investigation of all the forms included under them. Even in such a cursory review as the present it is necessary to compare *E. edulis* with *E. neriifolia* in order to define the limits of the one as against those of the other species.

It is unfortunate that the greatest difference of opinion prevails among taxonomists as to just what Linnæus had in mind when he published *E. neriifolia.* Hamilton [27] rejected the Linnæan binomial altogether, believing it to be meaningless. Roxburgh [28] and Cooke [29] limited it to the terete-stemmed form understood by them as *E. Nivulia,* and proposed to name *E. ligularia,* the spurge which the majority of taxonomists treat as *E. neriifolia.* Talbot's [30] account is most confused, and it is possible that his *E. ligularia* [31] is in reality an unnamed and undescribed species. Hooker f.[32] reduced the earlier homonym *E. varians* as a synonym of *E. Nivulia* and unaccountably followed Hamilton in accepting Rheede's *Ela Calli* to represent the same form illustrated by Wight [33] as *E. Nivulia.*

There can be no doubt that the references and illustrations used by Linnæus [34] under *E. neriifolia* define a group of species that belong to two different genera and are dissimilar except for accidental likeness of habit. Seba's [35] *Euphorbium* is *Elaeo-*

[27] Trans. Lin. Soc. 15 (1825) 286.
[28] Hort. Beng. (1814) 36; Fl. Ind. 2 (1832) 46.
[29] Fl. Bombay Pres. 2 (1908) 563.
[30] Fl. Bombay Pres. Sind. 2 (1911) 432.
[31] Op. cit., *fig. 485.*
[32] Fl. Brit. Ind. 5 (1887) 255.
[33] Icon. Pl. Ind. Or. (1852) *pl. 1862.*
[34] Sp. Pl. 1 (1753) 451.
[35] Rer. nat. Thes. 1 (1743) 18, *pl. 9, figs. 1, 2.*

phorbia drupifera, from the west coast of Africa. Commelin's [36] two spurges are specifically unrelated. One is believed by most authors to represent *E. varians* (*E. Nivulia*), although in the poor specimen that was illustrated characters pointing to *Elaeophorbia drupifera* are not lacking. The very large leaves, the manifestly tapering growth of the stem, the large rounded spine shields, and the erect habit of the nectaria of the female flower, seem to me to indicate *Elaeophorbia drupifera,* despite Commelin's statement that the specimen illustrated had been sent by van der Pyl, governor of Colombo, Ceylon. The other Commelinian [37] spurge is sterile but is probably not distinct from Rheede's *Ela Calli.* Bradley's [38] illustration is manifestly a copy of Commelin's figure in the Praeludia, but Bradley's specimen was of South African origin and it does not seem probable that Commelin and Bradley had in mind the same species. Plukenet's [39] crude figure does not lend itself to critical discussion, although it may be accepted to represent *E. varians* (*E. Nivulia*). D'Isnard's [40] "Euphorbium No. 8" appears to be the same plant as that illustrated by Commelin in the Praeludia. The elder Burman [41] grossly misinterpreted the "Euphorbium No. 9" of D'Isnard which is almost certainly *E. clava* [42] from the Cape of Good Hope. Burman's animadversion, however, should be noticed, because it suggests that *E. caducifolia* might have been in cultivation and that it was confused with the other species of

[36] Pl. rar. Hort. Amstel. 1 (1697) 25, *fig. 3.*

[37] Prael. Bot. (1703) 22, 56, *fig. 6.*

[38] Hist. Pl. Succ. 3 (1725) 10, *fig. 28.*

[39] Phytogr. (1720) *pl. 230, fig. 4.*

[40] Mém. Acad. Roy. Sc. [1720 (1722)] 386.

[41] Loc. cit.

[42] D'Isnard refers to Plukenet's *Tithymalus* [Phytogr. (1720) *pl. 230, fig. 5*] which appears to be the same plant shown by Petiver [Gazophyl. (1721) *pl. 86, fig. 5*]. The illustrations of Plukenet and Petiver were copied from a collection of drawings belonging to Bishop Compton, of Fulham, and are almost certainly meant to represent *E. loricata.* Compton's drawings in all probability were the work of Hendrik Claudius, a German who accompanied Simon van der Stel in his expedition to Namaqualand [Waterhouse, Sim. Stel Journ. (1932) xx]. The *Tithymalus* of Plukenet and Petiver was found, and sketched, in the vicinity of Oliphant's River (Waterhouse, op. cit., 168, No. 861), which indicates that N. E. Brown errs in excluding [in Dyer's Fl. Cap. (2) 5 (1915) 342] the polynomials of Plukenet and Petiver from the synonymy of *E. loricata.* It is plain that D'Isnard confused *E. clava,* cultivated about 1700, with *E. loricata* which was not in cultivation in Europe before 1780.

the group. Rumphius's [43] *Ligularia* has the habit, broad wing crenation, and the comparatively short, oblong-cuneate leaves of *E. edulis,* and I am inclined to accept it as a satisfactory habit illustration of that species.

A specimen of *E. neriifolia,* which is technically the holotype of the species, is extant in the Linnæan herbarium. Though the photograph of the holotype in question indicates a sterile fragment, it is believed that this fragment cannot represent *E. varians* (*E. Nivulia*). So far as one can judge without actually seeing the specimen, the holotype of *E. neriifolia* agrees with the *Ela Calli* of Rheede and with the *Tithymalus* of Commelin, in the Praeludia. Accordingly I accept Rheede's illustration as typifying *E. neriifolia.*

For the purpose of comparing *E. edulis* and *E. neriifolia* as far as possible under natural conditions, a rooted stem of *E. edulis,* received from the Orto Botanico of Palermo, and one of *E. neriifolia,* sent by Mr. F. C. Osmaston and collected at Hinoo, Ranchi, Bihar, and Orissa, India, were grown and brought contemporaneously into flower. Further comparison was made of this material with the available iconography, with live and preserved specimens of *E. varians* (*E. Nivulia*) and *E. caducifolia,* and with dried samples of *E. neriifolia* and *E. edulis* in the herbarium of the Arnold Arboretum.

Euphorbia edulis and *E. neriifolia* differ as follows:

(*a*) Leaf essentially spatulate in *E. neriifolia,* tapering to a long (about 2 cm) petiole; oblong-cuneate in *E. edulis,* ending into a short (about 1 cm) petiole.

(*b*) Podarium (tooth to the wing or angle) figuring in longitudinal section a right-angled triangule in *E. neriifolia,* with the spine shield located almost at a right angle from, and close to the floral eye; podarium figuring an equilateral triangle in *E. edulis,* with the spine shield set at the vertex. In other words: The stem of *E. neriifolia* tends to be obscurely pentagonal or nearly terete, but the podaria are sharply upraised and, when crowded, form comparatively conspicuous angles, or wings. The stem of *E. edulis* is more nearly pentagonal, occasionally triangular; its podaria slope gently, forming broad, even crenations; the angles are obscure.

It is believed that although individual variations may occur, the shape of the podaria is reasonably constant on young stems of both species.

[43] Herb. Amb. 4 (1743) 88, *pl. 40.*

(*c*) First peduncle of the cyme (that is, the peduncle below the first dichotomy) terete, and evolute, up to 10 mm long in *E. neriifolia;* clavate, stout, not over 3 to 4 mm long in *E. edulis.*

On account of the length of the first peduncle the cyme of *E. neriifolia* is manifestly pedunculate; that of *E. edulis* manifestly subsessile.

The length of the first peduncle of the cyme is a diagnostic character of the first importance. Although in the succulent *Euphorbia* the peduncles often elongate during anthesis and fructification in these two species, the first peduncle of the cyme almost immediately attains its normal length, practically stopping growth before the female stage of anthesis begins. It is suggested that Indomalayan, Indochinese, and Chinese specimens of species of this group having subsessile or sessile cymes may be suspected of belonging, *ipso facto,* to *E. edulis.*

(*d*) Nectarium (gland) always yellow-green in *E. neriifolia;* always pink to pale brown in *E. edulis.* The inner and outer margins of the nectarium are manifestly lipped in *E. edulis,* and scarcely or not lipped in *E. neriifolia.*

The reddish color of the nectarium sometimes persists on dried cyathia of *E. edulis.* The thin, upraised lips at the margins of the nectarium of the same species are usually present in water-soaked specimens.

(*e*) Stigma scarcely 1 to 1.5 mm long in *E. neriifolia;* 2 to 3 mm long in *E. edulis.*

These differences and the different geographic range are in my opinion adequate to establish *E. edulis* and *E. neriifolia* as distinct species.

Euphorbia edulis is not likely to be confused with either *E. caducifolia* or *E. varians* (*E. Nivulia*). The former is a strongly characterized species [44] with nearly terete stems and very abruptly upraised knoblike podaria. Its spine shield is usually large and armed with well-developed pungent thorns. Its cyathium is barely half as broad as those of *E. neriifolia* and *E. edulis* (that is, not over 3 to 5 mm broad at the mouth). Its leaf is much reduced, in young specimens somewhat narrowly ligulate. *Euphorbia varians* (*E. Nivulia*) has terete stems, pedunculate cymes, and podaria scarcely, if at all, upraised.

[44] Fischer in Kew Bull. (1925) 341.

Genus EUPHORBIA Linnæus

Subgenus TITHYMALUS Persoon

Tithymalus PERSOON, Syn. Pl. 2 (1806) 10; *nec alior.*; § *Grandifoliae* Berg., Sukk. Euph. (1907) 34, excl. (*E. drupifera*).

Subsection EUNEFOLIEAE novum [45]

EUPHORBIA EDULIS Lour.

Euphorbia edulis LOUR., Fl. Cochin. 1 (1790) 298; ed. (1) 2 (1793) 365 *non* Sessé and Mocino, Pl. Nov. Hisp. 81 (1887); RAEUSCH., Nom. Bot. (1797) 139; BOISS. in DC. Prodr. (2) 15 (1862) 80; GAGNEPAIN in Lecomte, Fl. Gén. Indo-Ch. 5 (1915) 254; CROIZAT et METCALF (discr. emend).

Euphorbia neriifolia auct. *non* I. *sensu* de Cand., Hist. Pl. Gr. (1799) *pl. 46;* LAM., Enc. Méth. 2 (1786) 415; PERSOON, Syn. Pl. 2 (1806) 11; HAW., Syn. Pl. Succ. (1812) 130; COLLA, Hort. Ripul. (1824) 54; ? GAGNEPAIN in Lecomte, Fl. Gén. Indo-Ch. 5 (1915) 239.

Euphorbia laurifolia HORT. Bot. Panorm. *non* Lam.; Bull. Ort. Bot. Palerm. app. 3 2 (1898) xviii.

Tithymalus aizoides, arborescens, spinosus, caudice angulari, nerii foliis BONELLI, Hort. Rom. 15 (1772) *fig. 28, non* Commel. Prael. Bot. (1703) *pl. 22.*

? Ligularia, Rumph. Herb. Amb. 4 (1743) *pl. 40* (*quoad habitum*).

Frutex succulentus, 3- ad 4-gonus, laxe ramosus, ad 4 ad 5 m altus. Foliis carnosulis, enerviis, integerrimis, ad 14 cm longis, 5 cm latis, oblongo-cuneatis, in petiolum crassum circa 1 cm longum abeuntibus. Cymis subsessilibus, pedunculo primario clavato vix 2 ad 3 mm longo, pedunculis secundariis ad 10 mm longis. Cyathio 8 ad 10 mm lato; nectariis nequaquam viridibus, vulgo brunneis 1, roseis, in sicco interdum coccineis, contiguis, 5×2 mm magnis, bene ad margines labiatis; lobis viridibus, late spatulatis, fimbriato-laciniatis, 2×3 mm magnis; bracteis ad cyathium 2, arcte amplectentibus, ovato-truncatis 1. Quadrangulis, mucronatis, dorso carinatis, apice eroso-denticulatis. Floribus ♂ ca. 40 in 5 fasciculis bene congregatis, apice purpureis; staminodiis plurimis, profunde laceratis. Flore ♀ incluso, ecalyculato, trigono, 2×2 magno, stipite teretiusculo sub apicem eroso fulto. Stylo 2 mm longo; stigmatibus capitatis, integris, 2 ad 3 mm longis, patentibus. Capsula ignota.

[45] A § *Tekeaneæ* (sphalm. *Tekeanae*) Croiz. [Bull. Jard. Bot. 15 (1938) 119] cymis minoribus, habitu, statura bene discedit; a subsect. *Sudaniceæ* subsect. nov. (Typus: *E. sudanica* Chev.) foliis semper integerrimis, aculeis binis, habitatu diversa.

Neoicotypus[46] *Metcalf 18578,* April 16, 1938, Campus Lingnan University Canton "Euphorbia Fl. yellow and red: woody, 4 m high" (icon. phot. specimina sicca, cymae in fluido in herb. Arn. Arb.).

Cymis subsessilibus, nectariis nequaquam viridibus, stigmatibus longiusculis, foliis oblongo-cuneatis breviter petiolatis, podariis saltem sub ramulorum apicem exacte triangularibus ab E. neriifolia optime differt.

[46] *Sensu* Furtado in Gard. Bull. Straits Settl. 9 (1937) 288.

CHIRONOMIDÆ FROM JAPAN (DIPTERA), XI

NEW OR LITTLE-KNOWN MIDGES, WITH SPECIAL REFERENCE TO THE METAMORPHOSES OF TORRENTIAL SPECIES [1]

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FIVE PLATES

In this paper I am discussing twenty-five chironomid midges, including three tanypodines, one diamesine, seventeen orthocladines, and four chironomines, collected from Honshu and Formosa.

Of these midges, the following five species were found on high altitudes in Formosa: *Spaniotoma nudipennis, S. niitakana, S. truncatocaudata,* and *S. takahashii,* on Mount Niitaka, at an altitude of 3,600 to 3,900 meters; and *Tanytarsus taiwanus,* on Mount Gokan at an altitude of 3,000 meters.

In my previous paper I reported three chironomids collected from hot springs, and at this time I intend to add two other species to the series of thermophilous midges. The chironomids collected are as follows: *Pentaneura okadai,* from Yunomine-Onsen, temperature 29.2° C.; *Chironomus lugubris,* from Unzen-Onsen, temperature 71° to 38° C.; *C. crassiforceps,* from Sozan-Onsen, temperature 38° C.; *Tanytarsus uraiensis,* from Urai-Onsen, temperature unrecorded; and *T. okadai,* from Tsubame-Onsen, temperature 36° C.

The metamorphoses of the following eleven species are also dealt with in this paper: *Anatopynia nebulosa, Chironomus crassiforceps, Heptagyia brevitarsis, Cardiocladius capucinus, Spaniotoma kibunensis, S. kanii, S. tentoriola, S. saxosa, S. suspensa, S. filamentosa,* and *S. intermedia.* The nine last-named species are truely torrential in habitat, and their immature forms are distinguishable by the following key.

Key to the species of torrential midges.

LARVÆ

1. Head with a pair of blunt tubercles; posterior pseudopods with numerous claws which are arranged into several complete rings.
Heptagyia brevitarsis (Tokunaga).

[1] Contribution from the Entomological Laboratory, Kyoto Imperial University, No. 74.

Head without tubercles; posterior pseudopods each with sixteen claws at most .... 2.

2. Median tooth of mentum very broad, finely serrulate; posterior pseudopods each with only ten claws...... *Cardiocladius capucinus* Zetterstedt.
   Median tooth of mentum otherwise; posterior pseudopods with more claws .... 3.
3. Mandibles each with two simple setæ at base of cutting edge; posterior pseudopods each with fifteen claws........ *Spaniotoma tentoriola* sp. nov.
   Mandibles each with one or more plumose setæ at base of cutting edge; posterior pseudopods each with sixteen claws........ 4.
4. Basal tubercles of caudal tufts entirely or partially thickened........ 5.
   Basal tubercles of caudal tufts entirely fleshy........ 6.
5. Median tooth not subdivided; basal tubercles of caudal tufts partially thickened on caudal side........ *Spaniotoma suspensa* sp. nov.
   Median tooth subdivided; basal tubercles of caudal tufts entirely thickened .... *Spaniotoma kibunensis* sp. nov.
6. Head black .... 7.
   Head brown or yellow .... 8.
7. Premandibles spatulate distally; mesal lobe of hypopharynx with simple processes; ventral anal gills tubular........ *Spaniotoma kanii* sp. nov.
   Premandibles each with a small pointed projection on distal edge; mesal lobe of hypopharynx with serrulate processes; ventral anal gills constricted .... *Spaniotoma intermedia* sp. nov.
8. Premandibles slender; mesal lobe of hypopharynx with spatulate processes; anal gills all swollen basally.... *Spaniotoma filamentosa* sp. nov.
   Premandibles spatulate distally; mesal lobe of hypopharynx with trichoid processes; anal gills with dorsal pair short, oval, ventral pair tubular. *Spaniotoma saxosa* sp. nov.

PUPÆ

1. Abdominal terga without spinose ridges or patches. *Heptagyia brevitarsis* (Tokunaga).
   Abdominal terga with spinose ridges or patches........ 2.
2. First abdominal tergum with spinose ridges. *Cardiocladius capucinus* Zetterstedt.
   First abdominal tergum without spinose ridges or patches........ 3.
3. Ultimate ninth abdominal tergum with caudal bristles........ 4.
   Ultimate ninth abdominal tergum without caudal bristles........ 6.
4. Thoracic respiratory organs absent........ *Spaniotoma kibunensis* sp. nov.
   Thoracic respiratory organs present........ 5.
5. Sixth to eighth abdominal terga with caudal spinose ridges. *Spaniotoma tentoriola* sp. nov.
   Sixth to eighth abdominal terga without caudal spinose ridges. *Spaniotoma filamentosa* sp. nov.
6. Thoracic respiratory organ absent........ *Spaniotoma intermedia* sp. nov.
   Thoracic respiratory organ present........ 7.
7. Second and third abdominal terga without spinose ridges or patches. *Spaniotoma kanii* sp. nov.
   Second and third abdominal terga with spinose ridges or patches........ 8.

8. Eighth abdominal tergum with a spinose patch.
Spaniotoma suspensa sp. nov.
Eighth abdominal tergum without spinose patches.
Spaniotoma saxosa sp. nov.

Biological observations of these torrential midges will be reported in detail in the future by Mr. Tokichi Kani, of Kyoto Imperial University.

The taxonomic system adopted in this paper is mainly that of Dr. F. W. Edwards.(2) The morphological terminology is based on my previous papers. The antennal ratio is the ratio between the length of the ultimate segment and the combined length of the remaining segments, except the scape, and, in the case of the males of the Tanypodinæ, between the combined length of the ultimate two segments and the combined length of the remaining segments, except the scape. The leg ratio is the ratio of the length of the first tarsal segment of the leg to that of the tibia.

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TANYPODINÆ

ANATOPYNIA NEBULOSA Meigen.

Anatopynia nebulosa MEIGEN, Philip. Journ. Sci. 62 (1937) 40, 41; Fauna Nipponica No. 16 (1937) 80–82.

A male fly was reared from a pupa found in a small stream in the botanical garden of Kyoto Imperial University.

Male.—Body about 7 millimeters long, black in ground color. Head entirely black; thorax almost entirely black, slightly pruinose and brown at shoulder parts; postscutellum setigerous on caudomeson; abdomen mainly black, white and hyaline at caudolateral corners of second to seventh terga. Antennæ 15-segmented; antennal ratio about 2.5. Wing comparatively narrow, with anal lobe round; wing markings somewhat more obscure than in female. Haltere white. Legs mainly black; tro-

chanters and femora brownish; tibiæ somewhat brown, broadly at middle; tarsal beards absent; leg ratio about 0.73 in foreleg, 0.59 in middle leg, and 0.61 in hind leg. Hypopygium (Plate 2, fig. 25) black, with styles short, stout, setigerous on inner side.

Pupa.—Length about 10 millimeters; exuviæ brown, semihyaline. Head and thorax without distinct tubercles and bristles. Thoracic respiratory organ (Plate 3, fig. 67) flattened, finely imbricate. Foreleg sheath with a mesal distinct projection at tibial end. Abdominal segments with characteristic markings of spinulous areas and chætotaxy; markings of dark spinulous areas as follows: On dorsal side, first tergum without special dark area; second to seventh terga similar, each provided with a pair of small lateral areas on cephalic part and a large mesal area (Plate 3, fig. 73); eighth tergum without lateral areas, with a large subtriangular mesal area; remaining terga without distinct areas. On ventral side, first sternum without special spinulous areas; second and third sterna with a pair of large lateral subtriangular areas; fourth to seventh sterna each with a large area formed by fusion of paired areas; other sterna without distinct areas. Abdominal chætotaxy as follows: Each tergum typically with five pairs of setigerous tubercles on caudal half and a pair of small setæ on lateral sides; first tergum with four pairs of ordinary setæ on mesal part and two similar setæ on either lateral side; seventh tergum with six swimming hairs on either lateral side in addition to five pairs of setigerous tubercles; eighth tergum with five swimming hairs on either lateral side and only one pair of small mesal ordinary setæ on caudal part; on ventral side, each sternum typically with only two pairs of slender setæ on caudal part and one small seta on either lateral side; first sternum without distinct setæ; second sternum with only one pair of mesal setæ; eighth sternum without ventral setæ. Each swimming paddle of ultimate segment large, elongate, sharply pointed, fringed with delicate hairs on lateral side, finely serrulated apically, with two large isolated setæ on basal part of lateral margin (Plate 3, fig. 87); sheaths of hypopygium comparatively small, not extending caudad beyond caudal incision between swimming paddles.

Specimens.—Alcoholic male and its pupal exuvia; Kitashirakawa, Kyoto, December 6, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected and reared by M. Tokunaga.

PENTANEURA ESAKII sp. nov.

This species was collected at light in summer at Kiso, Honshu.

Male.—Body about 2.2 millimeters long, yellowish white in ground color, with four brown scutal vittæ; abdominal terga of third, fourth, sixth, seventh, and eighth segments mainly dark brown. Head with occipital side pale brown, a brown V-shaped marking on vertex, other parts white. Antenna 15-segmented; scape bicolored, being white on proximal half and pale brown on distal half; flagellum and plumose hairs brown; antennal ratio 0.63 (10.5 + 4 : 23). Thorax with four brown distinct scutal vittæ; caudoscutal area with two small brown obscure stripes; scutellum yellowish white; postscutellum brown; pleural side with two brown spots, one on anterior and one on posterior notepisternum. Legs entirely yellowish white. Wing (Plate 1, fig. 1) slightly dark uniformly, without special markings; all veins brown; R_2 distinct; R_3 obscure. Abdomen bicolored; first, second, and fifth terga entirely white; third and fourth terga largely dark brown, each with a pale narrow band on caudal margin; sixth, seventh, and eighth terga uniformly dark brown; ninth tergum pale brown. Hypopygium (Plate 2, fig. 27) white; coxite slender, with a basal pubescent lobe; style slender, finely pubescent basally, with about three delicate setæ, apical spine yellow.

Female.—Body about 1.4 millimeters long; color somewhat paler than in male. Antenna 12-segmented; ultimate segment elongate, with a small apical projection and a terminal seta; proportional length of four distal segments as follows: 13 : 12.7 : 12.7 : 33.5; scape entirely white; antennal ratio about 0.23; proportional length of five segments of maxillary palpus 2 : 3 : 7 : 8 : 15. Pleural side of thorax with only one distinct brown spot, posterior pleural spot obscure. Wing (Plate 1, fig. 2) comparatively broad. Legs with strong tibial spurs; spurs of middle tibia distinctly unequal, larger spur fully thrice as long as shorter spur; empodium and pulvilli vestigial; leg ratio about 0.89 in foreleg, 0.94 in middle leg, and 0.76 in hind leg. Abdomen with third and fourth terga obscurely brown; cerci very small, vestigial; spermathecæ three, hyaline, equal, short-oval, each with a short neck region.

Habitat.—Honshu, Japan.

Holotype.—Male; Miure, Otaki-Mura, Nagano Prefecture; August 19, 1937.

Allotopotype.—Female; August 19, 1937.

Paratopotypes.—Females; August 19, 1937.

Type specimens.—Alcoholic; deposited in the entomological laboratory of Kyushu Imperial University; collected by Prof. T. Esaki and Mr. K. Yasumatsu.

This species is closely allied to *P. divisa* Walker, but very easily distinguished by the small value of the male antennal ration and by the presence of middle distinct scutal vittæ in both sexes.

PENTANEURA ESAKIANA sp. nov.

This midge was collected at light at Kiso, Honshu.

Male.—Body about 4.5 millimeters long, snowy white; wing without markings. Head with black eyes. Antenna 15-segmented, with flagellum pale brown; plumose hairs white; ultimate segment with a short apical seta; antennal ratio about 1.62 (29+8: 29). Legs without beards; pulvilli absent; relative lengths of legs 67: 85: 69: 35: 23: 17: 9 in foreleg, 73: 72: 40: 18: 14: 13: 7 in middle leg, and 65: 96: 66: 37: 27: 18: 7 in hind leg. Wing closely similar to that of *P. melanops,* with thick hairs spread over entire surface; veins yellow; costa very slightly produced beyond end of R_{4+5}; fork of R_{2+3} complete; R_3 ending beyond middle between ends of R_1 and R_{4+5}. Abdomen almost entirely white; eighth tergum somewhat brown on anterior half; hypopygium with three pubescent projections (Plate 2, fig. 26) between bases of coxites; styles angulated, entirely pubescent.

Habitat.—Honshu, Japan.

Holotype.—Alcoholic male; Miure, Otaki-Mura, Nagano Prefecture; August 19, 1937; deposited in the entomological laboratory, Kyoto Imperial University; collected by Prof. T. Esaki and Mr. K. Yasumatsu.

This midge is very closely allied to *P. melanops* Meigen, but distinctly different in the absence of the thoracic scutal vittæ and in the presence of the three basal projections between the coxites.

DIAMESINÆ

HEPTAGYIA BREVITARSIS (Tokunaga).

Prodiamesa (Monodiamesa) brevitarsis TOKUNAGA, Philip. Journ. Sci. 59 (1936) 528–530; Fauna Nipponica No. 16 (1937) 42, 43.

On examination of the metamorphosis of this species I am transferring it from *Prodiamesa* to the genus *Heptagyia.* Many larvæ and pupæ of this species were found clinging to rocks at the splash line in a rapid stream at Kibune, Kyoto. I have ob-

tained several imagines from these pupæ and I am confident that they are quite identical with *Prodiamesa brevitarsis* the male of which has been reported in my previous paper.(13)

Female.—Body about 2 millimeters long, black in ground color; thorax very shiny, with small setæ. Head with eyes reniform, widely separated from each other, separation as wide as their vertical lengths; frontal tubercles present, but far smaller than in male; antenna 7-segmented (18: 23: 15: 20: 18: 18: 34); third segment spherical, other distal segments all oval; ultimate segment with several short apical setæ; maxillary palpus with four distinct segments (3: 3: 6: 11). Thorax with pronotum very widely separated at middle, with several setæ on either lateral side; postscutellum hemispherical. Legs dark brown, proportional lengths of segments as follows: 55: 34: 22: 12: 7: 4.5: 8 in foreleg, 40: 51: 22: 11: 6.3: 3.5: 8 in middle leg, and 55: 58: 30: 17: 10: 5: 9 in hind leg. Haltere yellow. Wing (Plate 1, fig. 3) slightly brown by transmitted light, distinctly brown in cell Sc and distal part of cells R_1 and R_3 and along M_{1+2}; veins dark brown; alula with a few marginal setæ; vein R_{2+3} atrophied on distal half or more; stem of M very slender but distinct; M_{3+4} anastomosed with Cu_1 at its inflected point: Cu_1 slightly undulate at distal end. Abdomen black, with short setæ; cerci (Plate 2, fig. 46) somewhat pentagonal, dark brown; spermathecæ (Plate 3, fig. 47) three, spherical, mainly dark brown, pale brown only at basal part, without thickened neck region.

Pupa.—Body length about 2.2 to 2.8 millimeters in male and 3.5 to 3.8 millimeters in female; exuvia dark brown on head, thoracic region, and abdominal end, and almost colorless and hyaline on abdominal region. Head with a pair of blunt tubercles between antennal bases, each of these tubercles with small black seta on frontal side; sheath of antenna mainly dark brown, with apical part hyaline and colorless, with a black minute terminal thorn. Thorax dark brown, entirely, distinctly shagreened; pronotum very widely separated at middle, each lateral half produced laterad, forming a ridge, with about three setæ; scutum with a pair of lateral ridgelike thickenings between bases of wings and respiratory organs; each lateral side with about five setæ near respiratory organ, an isolated seta on dorsocephalic margin, three setæ before wing base, a seta dorsad of wing base, a seta on middorsal part; scutellum with a pair of simple setæ at lateral sides; respiratory organ (Plate 3, fig. 69)

black, triangular, sharply pointed, covered with small delicate hairs and with a gelatinous layer. Abdomen hyaline, clear, almost entirely spinulous; ventral side somewhat darker than dorsal side, especially on posterior segments; abdominal setæ almost simple, small, slender and indistinct. Chætotaxy of abdominal segments as follows: Tergum typically with a pair of small setæ on cephalic part, three pairs on caudal margin, and an isolated seta on either lateral side; pleuron with two setæ on cephalic part and two smaller setæ on caudal part; sternum with three pairs of very small setæ on mesal part; ultimate segment (Plate 3, fig. 88) dark brown, with a pair of small lateral ridges, a pair of minute setæ on dorsal side; each lateral ridge with three hooklike strong setæ; genital sheaths of both sexes prominent; penultimate segment of female with small dark sheaths of valvulæ.

Larva.—Body about 5 to 5.2 millimeters long in full-grown stage; head with blunt tubercles; thorax and abdomen with characteristic markings of cuticular armature. Head black, with a pair of blunt tubercles on vertex; frontal plate without tubercular projections. Antenna (Plate 4, fig. 95) situated on prominent basal erection, consisting of four segments; proximal two segments black; third segment longer than preceding, with spiral ental thickening; ultimate segment conical, minute, hyaline; first segment with a large trichoid sensilla on distal end; second with three black minute thickenings on distal end. Clypeus uniformly thickened; labrum (Plate 4, fig. 116) membranous, with several pairs of simple trichoid and peglike appendages on mesal area, several comblike armatures and about fourteen serrulate hooklike appendages on either side; epipharynx with a pair of prominent premandibles, a Y-shaped thickening, and hooklike and hairlike appendages; premandible (Plate 4, fig. 106) serrated into about eight small teeth, with several accessory setæ on lateral side; Y-shaped thickening consisting of a pair of narrow sclerites which are not fused with each other on the part of stem; membranous area between arms of Y-shaped thickening with five large somewhat spatulate hooklike appendages on mesal area, two finely serrulate hooklets and two simple hooklets along mesal side of each arm of Y-shaped thickening, and four hairlike appendages on distal area. Mandible with five teeth, a hyaline long trichoid projection at base of cutting teeth, about eleven basal setæ arranged radially, in this closely resembling *H. lurida* Garrett, reported by Dr. L. G.

Saunders.(9) Maxilla (Plate 4, fig. 120) consisting of two lobes; lateral lobe with a large disclike palpus, a tuft of hyaline setæ, a long simple and a small branched seta; mesal lobe with several trichoid sensillæ, highly setigerous on distal area. Labium with a large black mentum (Plate 5, fig. 139) which carries seven pairs of lateral teeth and a median tooth, and a pair of simple accessory basal setæ. Hypopharynx (Plate 5, fig. 140) with apical lobe highly spinose, with large hooklike ventral spines, numerous simple apical spines, and two pairs of small sensillæ; dorsal wall highly spinose, with numerous minute simple spinules. Thoracic and abdominal region (Plate 4, fig. 110) dark brown, with characteristic black markings on convex dorsal side, yellowish white on flattened ventral side. Thoracic pseudopod distinctly bilobate, with numerous golden-brown, slender, simple hooklets. Posterior pseudopods large, short, cylindrical, projecting ventrad, each forming a terminal sucking cup, surrounded by five or seven almost complete circles of dark-brown simple claws (Plate 5, fig. 150). Anal gills small, four, three projecting caudad and one cephalad between pseudopods as stated by Dr. L. G. Saunders.(10) Caudal tufts of setæ short, black, each consisting of four simple and two branched setæ, without distinct basal tubercle. Cuticular armature similar to that of Saunders's *H.* sp. A.(10)

Nest case.—Larvæ free-living, without special nest cases. Pupæ enclosed in gelatinous nest cases. Pupal case with double wall; external wall thick, gelatinous, convex dorsad, oval, about 6 to 8 millimeters long and 4 to 7 millimeters wide; internal wall of pupal case very thin, hyaline, parchmentlike, closely and completely surrounding pupal body; larval skin retained on posterior segments of pupa, being enclosed within the parchmentlike sack together with pupa.

Habitat.—Hygropetric, torrential stream; Honshu, Japan.

Allotopotype.—Female; Kibune, Kyoto; February 21, 1937.

Paratopotypes.—Males and females; February 19 and 27, 1937.

Type specimens.—Alcoholic and dry imagines, alcoholic pupæ and larvæ; Kibune, Kyoto; February 2, 1935, and February 19 and 27, 1937; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. T. Kani and M. Tokunaga.

The immature stages of the genus have been reported by Dr. L. G. Saunders(9, 10) in detail. The present species is closely allied to his *H. rugosa* in the structures of the larval head, but quite different in the structures of the posterior pseudopods and

the thoracic and abdominal cuticular markings of the larva and the thoracic respiratory organs of the pupa.

ORTHOCLADIINÆ

BRILLIA MODESTA Meigen.

This midge was collected at Kibune, Kyoto, in autumn.

Male.—Body about 3 to 3.2 millimeters long; thoracic ground color pale brown. Head with vertex brown; antenna pale brown, with scape brown; antennal ratio about 1.08 to 1.12; maxillary palpus pale brown, 5-segmented (12: 20: 75: 68: 67). Mesothoracic scutum brown, with three vittæ; middle vitta dark brown, reaching caudal margin of scutum; lateral vittæ black; scutellum brown; postscutellum black; pleural and sternal sclerites brown. Legs almost entirely pale brown; middle and hind coxæ brown; proportional lengths of segments of foreleg 49: 60.5: 52: 25.5: 18.5: 13.5: 7.9, those of hind leg 56: 67.5: 36.5: 24.5: 19.5: 12.8: 7.5. Wing (Plate 1, fig. 4) with costa produced beyond end of R_{4+5}; r-m long, slightly curved; R_1 about two-thirds of R_{4+5}; fMCu slightly before fR. Haltere white. Abdomen uniformly brown; posterior four or five terga sometimes dark brown; hypopygium (Plate 2, fig. 28) with coxite slender; style basally pubescent, almost straight, with a very long basal projection subequal in length to the style itself; basal lobe of coxite slightly setigerous on ventral side.

Specimens.—Alcoholic males; Kibune, Kyoto; October 16, 1934; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

BRILLIA JAPONICA sp. nov.

This midge is very abundant in Kyoto, especially in spring and autumn.

Male.—Body about 3.2 to 4.3 millimeters long; coloration closely similar to that of *B. longifurca* Kieffer. Head with mouth parts and antennæ brown. Antenna 14-segmented; third and fourth segments transverse, fifth somewhat cylindrical, other distal segments elongated, cylindrical; antennal ratio variable, from 0.7 to 0.97 (mean value, 0.836). Thorax yellowish pale brown; pronotum dark brown at middorsal side; scutum with three dark-brown vittæ; caudoscutal area with two short brown stripes; scutellum brown; postscutellum dark brown; pleural and sternal sclerites dark brown. Legs mainly brown, coxæ of middle and hind legs dark brown; forelegs and hind legs with relative lengths of segments 67: 87: 68: 35: 27: 19: 11

and 52: 67: 53: 26: 20: 15: 9, respectively; foreleg ratio 0.71 to 0.88 (mean value 0.794). Haltere white. Wing with thick macrotrichia spread on entire surface; costa produced beyond end of R_{4+5}; r-m slightly curved; fMCu just before fR. Abdomen yellow in ground color, with brown bands; first tergum with one pair of brown spots, second to fifth terga each with a brown narrow band, other caudal terga mainly brown, very narrowly yellow along caudal margin. Ultimate tergum (Plate 2, fig. 29) with reticular impression of integument; coxite with a long lobe which is pubescent only on ventral side; style bifurcate, lateral lobe about half as long as mesal lobe.

Female.—Body 2.5 to 4.1 millimeters long; color as in male. Antenna 6-segmented (3.5: 7: 4: 4.7: 4.9: 5.1). Maxillary palpus 5-segmented (3: 5: 13: 13: 14). Foreleg ratio 0.77 in mean value. Wing (Plate 1, fig. 5) comparatively broad; vein Cu_1 almost straight; fMCu under middle of r-m. Cercus (Plate 2, fig. 48) highly setigerous, with a long ventral lobe; spermathecæ (Plate 2, fig. 49) two, pear-shaped, yellow.

Habitat.—Honshu, Japan.

Holotype.—Male; Yamashina, Kyoto; November 18, 1935.

Allotopotype.—Female; November 18, 1935.

Paratypes.—Males and females; Kyoto: Hachijo, May 23, 1930; Kibune, October 2 and 16, 1930 and 1934, and April 22, 1932; Kitashirakawa, November 3, 13, 15, and 22, 1935; Yamashina, November 18, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

The present species is very closely allied to *B. longifurca* Kieffer, but in the allied species the antennal ratio is very large, being 2.5, and the male hypopygium is provided with longer and more distinctly curved styles.

METRIOCNEMUS (PARAMETRIOCNEMUS) STYLATUS Kieffer.

The males were swarming on still water in spring.

Male.—Body about 3.4 millimeters long, wing 2.4; ground color yellow. Head mainly yellowish brown; occipital region dark brown; eyes bare, distinctly extending dorsad. Antenna 14-segmented, with flagellum brown, scape dark brown; ultimate segment irregularly swollen on apical part, with four long preapical sensory setæ (Plate 1, fig. 24); antennal ratio about 1.07; mouth parts yellowish brown; palpus 5-segmented (2: 3: 7: 9: 13). Thorax yellow in ground color; pronotum brown at

middle on either side; scutum with four distinct dark-brown vittæ; caudoscutal area brown; scutellum with black marginal ring; postscutellum black; pleural sclerites brown; sternal side dark brown. Legs brown, with forecoxæ yellow, middle and hind coxæ brown; proportional lengths of segments of fore and hind legs 51: 59: 43: 24: 16: 11: 6 and 52: 62: 38: 19: 15: 7.5: 6.5, respectively; foretibiæ each with a long spur; middle tibiæ each with two small spurs; hind tibiæ each with a long and a minute spur; no tarsal spurs; claws each with two minute apical teeth; empodium slender, shorter than claws; pulvilli vestigial. Wing (Plate 1, fig. 6) with thick decumbent macrotrichia; squama fringed, with about eight setæ on basal half; veins yellow; costa produced beyond end of R_{4+5}; R_1 about half as long as R_{4+5}; R_{2+3} extending closely along R_{4+5}; r-m vertical; fMCu slightly beyond fR; Cu_1 slightly undulate. Haltere white. Abdominal terga largely brown, very obscurely pale brown along caudal margin of each tergum. Hypopygium (Plate 2, fig. 30) with setigerous anal point which is hyaline only on bare apical part; coxite with blunt mesal lobe; style with distinct dorsal keel, apical spine yellow.

Specimens.—Alcoholic males; Nagaoka, Kyoto; April 5, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

CARDIOCLADIUS CAPUCINUS Zetterstedt.

This species is often found in a rapid clear stream. The pupæ are found in white oval nest cases on stones.

Male.—Body about 3.2 millimeters long, almost entirely black; frontal aspect of head dark brown, pleural membranes brown or dark brown, haltere white. Antenna 15-segmented, without apical setæ; antennal ratio about 1.48. Thorax entirely black. Legs with tarsal spurs on three proximal segments of all legs; claws slightly spatulate and finely pectinate at tip; no pulvilli; relative lengths of segments of fore, middle, and hind legs 54: 69: 54: 30: 17: 5.5: 9, 62: 66: 32: 22: 13: 5: 8, and 70: 83: 45: 26: 17: 5.5: 10, respectively; fourth tarsal segments (Plate 1, fig. 22) of all legs distinctly flattened, shorter than fifth. Wing (Plate 1, fig. 7) broad, with anal lobe round, without black spot on r-m, vein R_1 about half length of R_{4+5}, R_{2+3} ending before middle between ends of R_1 and R_{4+5}, fMCu just beyond fR, Cu_1 almost straight. Abdomen almost entirely black. Hypopygium (Plate 2, fig. 31) with ultimate tergum small, bilobate caudad, setigerous only on caudal margin, without anal point; coxite

elongated, with a distinct basal lobe; style with dorsal ridge slightly developed.

Female.—Body as large as male, somewhat paler than in male; frontal aspect of head pale brown; antenna mainly pale brown, with ultimate segment black; pronotum brown; scutum black, with shoulder parts brown; scutellum brown; postscutellum and pleural and sternal sclerites black; abdominal terga of first and second segments pale brown, other terga black. Antenna 7-segmented (18: 20: 15: 16: 18: 18: 58); ultimate segment with only one apical seta. Legs with claws simple; proportional lengths of segments 54: 69: 54: 30: 17: 5.5: 9 in foreleg, 62: 66: 32: 22: 13: 5: 8 in middle leg, and 70: 83: 45: 26: 17: 5.5: 10 in hind leg. Wing with anal lobe almost right-angled, R_1 shorter than half of R_{4+5}. Cercus (Plate 2, fig. 51) black; spermathecæ (Plate 2, fig. 52) somewhat pyriform, black, with hyaline neck part; fingerlike projection (Plate 2, fig. 50) of ninth segment longer than cerci. Other structures mainly as in male.

Pupa.—Body about 3.9 to 4.5 millimeters long, brown on head, thorax, and abdominal end. Head with papilliform frontal tubercles, with five very small papillæ: one on postclypeal region, two on preclypeal region, and two on scapes of antennæ, without distinct setæ. Thorax without special respiratory organs, distinctly shagreened on caudoscutal area and mesal area of postscutellum, without distinct tubercles. Abdominal dorsal side brown, extensively and finely spinulous; ventral side hyaline, smooth. Abdominal chætotaxy as follows: tergum with long *a*, *b*, and *e* and small *c* and *d* setæ, sternum with small *i* and *l* and minute *j* and *k* setæ, and either lateral side with long dorsal *g* setæ, and minute ventral *n* and two *o* setæ; eighth segment without dorsal *a*, ventral *i*, *j*, and *k*, and all lateral setæ; ultimate segment with only three strong setæ on caudal part of either lateral side. Characteristic arrangement of spinous areas as follows: thickly spinous transverse bands composed of black very long spines on anterior and posterior margins of first tergum and posterior margins of following seven terga; strongly shagreened transverse patches composed of black small spines on middle parts of second to seventh terga and a small similar patch caudad of caudal spinose band of seventh tergum; spinose oval patches composed of very small spines on caudolateral parts from second to seventh terga (Plate 3, figs. 75, 83, and 90). Ultimate segment of male with genital sheaths long, upcurved;

ultimate segment of female with short, papilliform genital sheaths which are visible in dorsal aspect.

Larva.—Body of full-grown form about 6.5 millimeters long, dark green. Head with frontal plate, margin of mouth opening, and occipital margin brown, other parts yellow; eye spots each consisting of two masses of pigment, of which the anterior mass is found in a round yellow area. Antenna (Plate 4, fig. 96) 5-segmented, black. Labrum (Plate 4, fig. 112) with short, simple, trichoid appendages. Epipharynx (Plate 4, fig. 113) with triple distomesal teeth, two pairs of large and two pairs of slender lateral teeth, five pairs of small lateral spines between arms of U-shaped thickening, basal plate elongate; premandible (Plate 4, fig. 105) nonserrate, spatulate on distal part. Mandible with five small cutting teeth, a long plumose hair which is very finely serrulate. Maxilla (Plate 4, fig. 124) very thickly fringed with various spines; palpus subdivided into two semicircular discs. Mentum (Plate 5, fig. 130) with a very broad median tooth which is very finely serrulate on distal margin, five pairs of lateral teeth small, basal setæ simple and single. Hypopharynx (Plate 5, fig. 141) fringed with long simple and serrulate spines, median lobe with four pairs of large and several small comblike scales, dorsal side with various small scalelike projections. Anterior pseudopod with claws arranged into about ten transverse lines; claws of basal seven lines very small, simple or pectinate, those of distal three lines very strong and simple; ventral side of pseudopod spinulose with very fine double and triple spinules arranged into about five transverse lines (Plate 5, fig. 154). Posterior pseudopod with ten large, strongly curved claws. Caudal tuft of setæ consisting of three long and two longer black setæ grown on a short dark-brown basal tubercle. Anal gills similar to each other, elongated, oval. Abdominal ventral and lateral sides often indigo blue due to subcutaneous pigment.

Nest case.—Larvæ free-living, without nest cases. Pupal cases white, oval, about 8 to 10 millimeters long and 4 to 6 wide.

Habitat.—Rapid stream.

Specimens.—Alcoholic imagines, pupæ, and larvæ; Kibune and Nishigamo, Kyoto; January, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. T. Kani.

The imagines of the Japanese specimens are somewhat different from those of the European in the possession of a shiny scutum and pale-brown abdominal base of the female. Immature

stages are very closely similar to those of *C. fuscus* Kieffer reported by Dr. L. G. Saunders(8) and Dr. A. Thienemann;(11) the pupal form, however, is distinctly different from *C. fuscus* in the arrangement of shagreened patches which are discontinuous in the allied species, being separated into four small patches.

CARDIOCLADIUS FUSCUS Kieffer.

Two females were collected at a light at Kiso in summer.

Female.—Body about 2.8 millimeters long, black in ground color. Head brown or dark brown, with mouth parts dark brown. Antenna with scape yellowish brown, flagellum dark brown, 7-segmented (13:18:13.5:13:14.5:16.5:51); ultimate segment with only one apical seta. Palpus black, 5-segmented (2:3.5:9:13:19), third segment distinctly thickened. Pronotum yellow; scutum somewhat shiny, with three black subconfluent vittæ which are obscurely separated by dark-brown stripes; shoulder parts and lateral margins of scutum yellow; postscutellum black; scutellum and pleural and sternal sclerites brown; pleural membranes yellow. Legs mainly dark brown or black; procoxa and bases of all femora yellow; trochanters of all legs yellowish brown; fourth tarsal segments of all legs (Plate 1, fig. 23) distinctly flattened. Proportional lengths of segments of legs 56:72:52:27:18:5.5:8 in foreleg, 62:63:30:19:13:5:8 in middle leg, and 65:75:43:24:16:5.5:8.2 in hind leg. Haltere white. Wing (Plate 1, fig. 8) with veins brown, a dark stripe along caudal margin of M_{1+2}, R_1 shorter than half of R_{4+5}. Abdomen yellow on two anterior segments, black on other segments.

Specimens.—Alcoholic females; Miure, Nagano Prefecture; August 19, 1937; deposited in the entomological laboratory, Kyoto Imperial University; collected by Prof. T. Esaki and Mr. K. Yasumatsu.

CARDIOCLADIUS ESAKII sp. nov.

This species was collected at a light at Kiso.

Female.—Body about 3.3 millimeters long, mainly black. Head dark brown, with palpus black; antenna with scape brown, flagellum black, 7-segmented (16:20:12:15:16:16:53). Thoracic coloration almost as in *C. capucinus*. Legs with proportional lengths of segments 60:76:55:29:19:5:9 in foreleg, 68:70:32:21:14:5:8.5 in middle leg, and 72:83:48:26:17:5:9 in hind leg; fourth tarsal segments (Plate 1, fig. 21) moderately flattened, being intermediate between those of two

preceding species. Abdomen with first tergum dark brown, other terga black, pleural and sternal sides mottled with indigo black.

Habitat.—Honshu, Japan.

Holotype.—Female; Miure, Nagano Prefecture; August 19, 1937; deposited in the entomological laboratory, Kyoto Imperial University; collected by Prof. T. Esaki and Mr. K. Yasumatsu.

This species is intermediate between *C. fuscus* Kieffer and *C. capucinus* Zetterstedt in coloration and shape of penultimate tarsal segments.

SPANIOTOMA (SMITTIA) NUDIPENNIS Goetghebuer.

This species was found at Mount Niitaka, Formosa.

Male.—Body about 2 millimeters long, black in ground color. Head black, with eyes very finely pubescent, mouth parts somewhat brownish; antenna dark brown, 14-segmented, very slightly swollen apically, with apical pubescence; antennal ratio about 1; intermediate flagellar segments from fifth to thirteenth cylindrical. Thorax velvet black; scutellum somewhat brown. Legs dark brown, with long suberect setæ besides small setæ; tibial spurs long; no pulvilli; segments of legs showing proportional lengths 29:36:18:12:8:5:4 in foreleg, 32:32:14:8.5:6:4:3.7 in middle leg, and 34:36:20:11:9:5:4 in hind leg. Haltere dark brown. Wing (Plate 1, fig. 9) milky white; costa very distinctly produced beyond end of R_{4+5}, R_{4+5} ending before level of end of M_{3+4}. Abdomen black, sometimes brownish; hypopygium (Plate 2, fig. 32) with very slender anal point; coxite with small mesal thickened lobe; style entirely pubescent, with dorsal ridge and preapical incision.

Specimens.—Alcoholic males; Mount Niitaka, Formosa; August 29, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

SPANIOTOMA (SMITTIA) NIITAKANA sp. nov.

This minute species was collected at Mount Niitaka, Formosa.

Male.—Body about 2 millimeters long, deeply black, darker than *S. nudipennis* Goetghebuer. Head with eyes pubescent. Antenna 14-segmented; ultimate segment not distinctly clavate, pubescent on apical one-third of nonplumose area, with an apical seta, and two preapical sensory setæ; antennal ratio about 2.1; intermediate flagellar segments very short and transverse. Maxillary palpus with five segments (7:18:51:42:46). Pronotum visible in dorsal aspect. Haltere black. Wing (Plate 1, fig. 10) milky white with black squama; vein R_1 about half as long as

R_{4+5}; R_{2+3} ending before middle between ends of R_1 and R_{4+5}; costa slightly produced; Cu_1 distinctly bent. Legs also black, without pulvilli; proportional lengths of segments of foreleg 40:48:25:15:10:6:5, of middle leg 44:45:19:11:8:5:5, and of hind leg 46:51:27:15:11:6:5.8. Abdomen also entirely black; hypopygium (Place 2, fig. 33) with a sharp anal point; coxite with a minute setigerous basal lobe; style with an apical projection and a yellow preapical spine.

Habitat.—Mountain region; Formosa.

Holotype.—Alcoholic male; Mount Niitaka, Formosa: August 24, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

This species is somewhat related to *S.* (*S.*) *aterrima* Meigen, but in the related species the anal lobe of the wing is obtuse, the eyes are more thickly pubescent, and the hypopygium is provided with specific styles, highly differing from the present species. *S.* (*S.*) *pratorum* Goetghebuer is also somewhat related to the present species, but is easily distinguished by the following characters: the antennal ratio is about 1.5, the eyes are bare, and the style of the male carries two apical spines. An undetermined species of the subgenus *Smittia* (sp. inc. no. 2) reported by Edwards(2) is most closely allied to the present species in the shape of the male hypopygium, and very probably identical with it.

SPANIOTOMA (SMITTIA) TRUNCATOCAUDATA sp. nov.

This very minute midge was also collected at Mount Niitaka, Formosa.

Male.—Body about 1.7 millimeters long; ground color dark brown; haltere black; wing milky white. Head with eyes bare. Antenna black, with dark plumose hairs; ultimate fourteenth segment gradually swollen apically, thickly pubescent with small stiff microtrichia on its entire length, with two apical setæ, subequal in length to nine preceding segments put together; flagellar segments from third to fifth transverse, lengths of sixth and seventh segments subequal to widths, remaining intermediate segments cylindrical; antennal ratio about 0.73. Frontoclypeus with four setæ; maxillary palpus 5-segmented (6:14:21:25:30), pale brown. Thorax dark brown; pronotum invisible in dorsal aspect; scutum with two lines of pale spots at bases of setæ along pseudosutural foveæ. Haltere black. Wing (Plate 1, fig. 11) milky white, with squama not black; costa slightly produced; R_{2+3} atrophied before costal margin; Cu_1 almost straight.

Legs with coxæ dark brown, other segments pale brown; tarsal spurs obscure; tibial spurs of middle leg extremely small; no pulvilli; fourth tarsal segments of all legs shorter than fifth (21: 25 in foreleg, 24: 19 in middle leg, and 25: 28 in hind leg), but not flattened. Relative lengths of segments of legs 26: 32: 13: 6: 5: 3.5: 4 in foreleg, 27: 29: 12: 6: 4: 3: 3.7 in middle leg, and 29: 32: 19: 9: 7: 4: 5 in hind leg. Abdomen dark brown or brown, with a pale middorsal line throughout entire length. Hypopygium (Plate 2, fig. 34) with ultimate tergum without anal point, setigerous with small stiff setæ on caudal margin; coxite with a large blunt setigerous, basal lobe; style with a thickened preapical dorsal ridge and a yellow apical spine.

Habitat.—Mountain region; Formosa.

Holotype.—Alcoholic male; Mount Niitaka, Formosa; August 24, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

This species somewhat resembles *S.* (*S.*) *albipennis* Goetghebuer; the allied species, however, is highly different in the following structures: antennæ with white or gray plumose hairs, antennal ratio larger than 1, vein R_{4+5} shorter, ending above middle of Cu_1, and ultimate tergum with a short anal point.

SPANIOTOMA (EUKIEFFERIELLA) TAKAHASHII sp. nov.

This very minute black species was found at Mount Niitaka, Formosa.

Male.—Body about 1.1 to 1.3 millimeters long, largely velvet black. Head black, with mouth parts and antennæ pale brown, plumose hairs yellowish brown; eyes oval, bare, very widely separated from each other; frontoclypeus with six setæ. Antenna 14-segmented, slightly clavate apically, with apical pubescence, without terminal setæ; ultimate segment shorter than five preceding segments taken together (54: 60); intermediate flagellar segments mainly cylindrical; antennal ratio very small, about 0.4. Palpus 5-segmented (6: 9: 12: 13: 20). Thorax velvet black; scutellum somewhat brownish; pleural membranes pale brown; sternal and pleural sclerites dark brown; pronotum highly reduced, completely invisible in dorsal aspect. Legs with coxæ brown; femora and tibiæ pale brown; tarsi whitish; middle and hind tibiæ each with two strong preapical bristles besides the two spurs; four proximal tarsal segments of all legs each with an apical spur; no pulvilli; fourth tarsal segment as long as or shorter than fifth (12: 16 in foreleg, 14: 16 in middle leg, and 15: 16 in hind leg); second and third tarsal segments

of hind leg subequal in length (41:41). Proportional lengths of segments of legs 18:21:10.5:4.5:4:2:2.5 in foreleg, 21:24:10.5:6:4.5:2.3:2.5 in middle leg, and 20:23.5:11:6.5:6.5:2.4:2.5 in hind leg. Wing (Plate 1, fig. 12) about 0.9 to 1 millimeter long, slightly milky white; veins almost hyaline; costa very short; R_1 about half as long as R_{4+5}; R_{2+3} extending closely along R_{4+5}; R_{4+5} ending at level of end of Cu_1; fMCu beyond end of R_1; M_{1+2} obscure on proximal part; M_{3+4} and Cu_1 atrophied before wing margin; squama quite bare. Haltere white. Abdomen brown or dark brown; hypopygium (Plate 2, fig. 35) with ultimate tergum bare; anal point blunt, setigerous at base, with thickened end; coxite without basal lobe; style with a small thickened ridge on apical part.

Habitat.—Mountain region; Formosa.

Holotype.—Male; Mount Niitaka, Formosa; August 23, 1936.

Paratopotypes.—Males; August 23, 1936.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

The present species is somewhat related to *S.* (*E.*) *coronata* Edwards and *S.* (*E.*) *camptophleps* Edwards. They are, however, easily distinguished by the following characters: In the former the antenna is provided with pubescence only at the extreme tip and the coxite of the hypopygium carries a square mesal lobe, and in the latter the antenna is provided with dark plumose hairs, the black thoracic vittæ are separated from each other by yellow stripes along foveæ, and the wing vein Cu_1 is distinctly bent and the costa produced beyond the end of R_{4+5}.

SPANIOTOMA (ORTHOCLADIUS) KANII sp. nov.

This species is common in a rapid stream in winter in Kyoto. The immature stages are found in gelatinous nest cases built on a stone in a torrent.

Male.—Body about 3.5 to 3.8 millimeters long, dark brown or black in ground color. Haltere yellow. Wing milky white. Head entirely dark brown, eyes bare. Antenna 14-segmented, with plumose hairs black, without apical setæ; antennal ratio 1.5 to 1.76. Palpus with four distinct segments (5:8:8:11.2). Thorax shiny, black; pronotum black; scutum with two lines of distinct pale spots at bases of setæ arranged along foveæ; scutellum highly setigerous, pale brown, with a black ring; postscutellum black; supra-alar setæ six or seven. Legs with coxæ black, other segments entirely dark brown; claws slightly spatu-

late and finely serrulate at tip; empodium very small; no pulvilli; apical tarsal spurs on two proximal segments of middle and hind legs. Foreleg ratio 0.76 to 0.79. Wing (Plate 1, fig. 13) slightly brown by transmitted light, with a prominent anal angle; Cu_1 slightly sinuous on distal part. Abdominal dorsal side dark brown, ventral side brown; hypopygium (Plate 2, fig. 36) black, with a setigerous anal point; coxite slender, with a mesal projection and a shallow concavity just beyond this projection; style with a large dorsal thickened ridge.

Female.—Body about 2.9 to 3.1 millimeters long, ground color yellow. Wing strongly milky white. Head with vertex dark brown, frontal aspect between eyes yellow; clypeus and labella pale brown. Antenna 6-segmented (4: 5: 2.5: 3: 3.5: 8); scape and basal half of second segment yellow, other segments entirely pale brown; ultimate segment with only one apical seta; antennal ratio 0.57 to 0.67. Palpus dark brown, with four distinct segments (3: 7: 7: 11). Thorax extensively yellow; scutum with three black distinct vittæ; scutellum yellow, with a black marginal ring; notepisternal sclerites with dark clouds; sternepisternum with a black stripe between bases of two coxæ on either side; sternal side black, with a yellow midsternal stripe. Legs with coxæ brown, trochanters yellow; in foreleg, femoral base yellow and other parts dark brown; in middle leg, femur mainly yellow and dark brown only at distal end; in hind leg, femur uniformly brown or dark brown; tibiæ and tarsi of all legs entirely dark brown; claws simple; foreleg ratio about 0.73 to 0.75; two distal segments of middle leg subequal in lengths to each other, but in other legs fourth somewhat longer than fifth. Wing (Plate 1, fig. 14) with basal area somewhat yellowish, and apical margin darkly fumose. Abdomen mainly yellow, each tergum with a rhombic dark-brown cloud; cercus (Plate 2, fig. 53) yellow, with a ventral projection black at tip; spermathecæ (Plate 2, fig. 54) two, unequal, mainly brown, with basal part pale brown, neck region also brown. Other structures mainly as in male.

Pupa.—Body 2.3 to 3.5 millimeters long; exuviæ brown on head, thorax, and genital sheaths, pale brown on abdominal dorsal side and hyaline on ventral side; setæ of thorax and abdomen brown. Head with a pair of very small frontal tubercles, without distinct setæ. Thoracic respiratory organ (Plate 3, fig. 68) somewhat oval, white, smooth, membranous. Chætotaxy of abdomen: Tergum typically (Plate 3, fig. 76) with five pairs of

small setæ (*a, b, c, d,* and *e*) ; sternum with four pairs of small setæ (*i, j, k,* and *l*) ; either lateral side with three slender setæ (*g, n,* and *o*) ; setæ *f, h,* and *m* obscure or absent; lateral swimming hairs absent; first and second terga without setæ *d;* first sternum without distinct setæ; eighth segment without dorsal setæ *a, b,* and *c,* and ventral setæ *i, j, k,* and *l;* ultimate segment (Plate 3, figs. 86 and 91) with a pair of small triangular caudolateral expansions which are larger in male than in female, and with two setæ on each expansion; male genital sheaths very large, portion beyond ultimate tergum far longer than ultimate tergum itself; female genital sheaths short, portion beyond caudal tergum about one-third as long as ultimate segment. Abdominal terga from fourth to ninth and sterna from second to seventh each with a triangular very finely spinulous area on anterior part. Terga from fourth to eighth each with a characteristic short caudal ridge of small spines; this spinulose ridge about one-third of tergal width, consisting of two or three transverse lines of various numbers of spines of which about forty are on the fourth tergum, forty-six on the fifth, thirty-five on the sixth, twenty-three on the seventh, and twenty-four on the eighth segment; these spines black on proximal part and hyaline on distal end.

Larva.—Body about 4.5 to 5 millimeters long in the full-grown stage, yellowish green in life. Head extensively yellow, with eye spots, mentum, mandibles, and occipital margin black. Each eye spot consisting of anterior small reniform and posterior large rhombic pigment mass. Antenna (Plate 4, fig. 104) 5-segmented. Labrum (Plate 4, fig. 114) with a pair of distomedian two-branched appendages on a common plate and many simple hooklike spines; epipharynx with a median strong hooklike appendage and three pairs of strong, one pair of very large, and two pairs of small similar appendages along U-sclerite; first median appendage with three ridges; premandible with a large cutting edge. Mandible with five teeth, a short hyaline projection on base of cutting edge, a hyaline plumose seta on mesal side, and two simple setæ on lateral side. Maxilla (Plate 4, fig. 121) consisting of a large mesal and a small lateral lobe; former lobe with many trichoid projections and several peglike sensillæ; latter lobe with a short maxillary palpus and a few trichoid projections. Mentum (Plate 5, fig. 131) with three broad median teeth, mesal tooth sometimes slightly concave on distal margins, and five or six teeth at either side; setæ of

mentum simple. Hypopharynx (Plate 5, fig. 142) fringed with many hyaline trichoid projections, with four pairs of brown peglike sensory organs, and a hyaline mesal lobe; the mesal lobe quite characteristic in structure for the species, being branched into many simple trichoid projections; dorsal wall of hypopharynx with many hyaline spines, growing inwardly. Thoracic pseudopod with yellow serrulate claws arranged into about fifteen transverse lines (Plate 5, fig. 157); posterior pseudopod with fifteen large, black, simple claws; caudal tuft of setæ consisting of a small fleshy tubercle and six long setæ; anal gills hyaline, unequal; dorsal gills oval, ventral gills slender and tubular.

Nest case.—Hyaline, gelatinous, usually dusty with diatoms on surface, oval; cases of full-grown larvæ and pupæ about 8 to 10 millimeters long, 4 to 5 wide, 3 to 4 high, closely applied on surface of stone. Both larval and pupal cases similar in shape.

Habitat.—Torrential stream; Honshu, Japan.

Holotype.—Male; Nishigamo, Kyoto; January, 1936.

Allotopotype.—Female; January, 1936.

Paratypes.—Males and females; Kyoto: Nishigamo, November 23, 1935, and January, 1936; Hiiragino, November, 1935; Kibune, February, 1936.

Type specimens.—Alcoholic imagines, pupæ and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. T. Kani and M. Tokunaga.

Allied species may be *S.* (*O.*) *nivosus* Kieffer, *S.* (*O.*) *atriplu-ma* Kieffer, *S.* (*O.*) *oblidens* Walker, and *S.* (*O.*) *thienemanni* Kieffer, which, however, differ from the present species in the following points; In the first allied species fifth tarsal segments of middle leg longer than fourth, these two segments in hind leg equal in length; in the second and third species the male antennal ratio is about 2, and the male hypopygium is provided with a characteristic mesal lobe; in the fourth species the male is provided with three distinctly separated dorsal vittæ on the mesoscutum.

SPANIOTOMA (ORTHOCLADIUS) KIBUNENSIS sp. nov.

This midge is very common along a rapid stream at Kibune, Kyoto, in the winter season. The immature forms are found in gelatinous nest cases closely adhering to the surface of stones at the splashline of clear streams.

Male.—Imagines extruded from mature pupæ about 3.7 millimeters long, almost entirely dark brown. Head with eyes bare; antenna 14-segmented; antennal ratio 1.12; palpus 5-segmented

(10: 14: 33: 44: 66). Legs with tarsal spurs on two proximal segments of middle and hind tarsi; all legs each with only one tibial spur; claws finely serrulate at tip, each with three strong basal setæ; empodium as long as claws; no pulvilli; relative lengths of segments of legs 34: 42: 30: 21: 17: 13.5: 8 in foreleg, 41: 42: 21: 15: 12: 9: 7 in middle leg, and 44: 50: 29: 19: 17: 11: 8 in hind leg. Hypopygium without anal point; ultimate tergum subdivided into two setigerous hemitergites; coxite with a mesal lobe which is very similar to that of *S.* (*O.*) *kanii.*

Female.—Ground color brown. Antenna 6-segmented 18: 26: 16: 19: 22: 46); ultimate segment with only two apical setæ; intermediate flagellar segments cylindrical or oval; palpus 5-segmented (13: 18: 33: 42: 65). Legs with proportional lengths of segments 38: 48: 32: 22: 17: 14: 9 in foreleg, 42: 46: 22: 14: 11: 9: 8 in middle leg, and 50: 56: 29: 21: 16: 11: 9 in hind leg; claws simple. Spermathecæ (Plate 2, fig. 55) two, spherical, brown, their basal parts hyaline; cerci (Plate 3, fig. 56) earlike.

Pupa.—Body 3 to 4 millimeters long. Exuviæ dark brown on head, thorax, and ultimate segment, brown on abdominal dorsal side, hyaline on ventral side. Head with two blunt frontal tubercles; frontoclypeal region with three small papilliform tubercles; antennal sheaths each with a ring of minute dots at base. Thorax without respiratory organs, almost entirely smooth; distinct setæ arranged on lateral half of thorax as follows: Two setæ on pronotum, two setæ on anterior margin of scutum, three setæ on laterocephalic margin of scutum, one seta before wing base, and one seta on middle part of scutum. Abdominal dorsal side almost entirely thickly spinulose, each tergum with a dark triangular area on anterior half and a dark narrow band before caudal margin; sternal side without spinulose areas. Chætotaxy: Dorsal side with five pairs of simple setæ (*a* to *e*), seta *e* large, *b* and *c* small; pleural side with six setæ (*g*, *h*, *n*, o_1, and o_2), seta *n* double, o_2 very fine and curly; sternal side with four pairs of simple setæ (*e* to *i*), setæ *i* and *k* large, seta *j* small; from sixth to seventh caudal segments with pleural setæ *g* and *h* not widely separated; eighth segment without dark, large, anterior dorsal area and with only one pair of dorsal setæ *e*, two pairs of ventral setæ *j* and *k*, and one strong lateral bristle, three slender lateral setæ, and one delicate curly seta on either laterocaudal corner. Terga from fourth to fifth (Plate 3, fig. 78) each with a specific caudal ridge consisting of black upcurved hooklets which are arranged in a line

along almost entire length of caudal margin; ultimate tergum (Plate 4, fig. 92) with two hemicircular laterocaudal expansions and three long, black, curved bristles on each expansion; male genital sheaths distinctly extending caudad, straight beyond caudal expansions, and female genital sheaths slightly beyond caudal expansions of ultimate tergum.

Larva.—Body about 3.5 to 5 millimeters long, indigo blue in life. Head oval, almost entirely black; eye spot consisting of a small round and a large reniform pigment mass on a yellow circular area. Antenna (Plate 4, fig. 103) 5-segmented; trichoid organ of first segment very long, fully as long as four distal segments taken together. Labrum closely similar to that of *Cardiocladius capucinus* Zetterstedt, with simple trichoid appendages, without bifurcate appendages; epipharynx (Plate 4, fig. 115) with five large hooklike projections between arms of U-shaped chitinization, and a large elongated median plate; mandible also as in *C. capucinus;* premandible (Plate 4, fig. 107) squarely spatulate at end; maxilla (Plate 4, fig. 123) with prominent palpus and several plumose setæ in addition to ordinary simple setæ and spines. Mentum (Plate 5, fig. 132) with five pairs of lateral teeth, a broad subdivided median tooth, and a pair of simple basal setæ. Hypopharynx (Plate 5, fig. 144) with two pairs of mesal comblike appendages, three pairs of lateral scalelike processes, and numerous marginal setæ, its dorsal wall with many small thornlike and comblike processes. Anterior pseudopod with numerous, very small, simple, serrate claws arranged into six transverse lines; large strongly curved claws arranged in a line and long slightly curved claws arranged into three lines at end of pseudopods, these claws (Plate 5, fig. 156) all golden yellow; posterior pseudopod with four small and twelve large black claws. Caudal tuft of setæ consisting of seven long brown setæ on a short chitinized tubercle.

Nest case.—Gelatinous, hyaline; in shape and size closely similar to *S.* (*O.*) *kanii;* one small respiratory opening on either end.

Habitat.—Hygropetric; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; February 27, 1937.

Allotopotype.—Female; February 27, 1937.

Paratopotypes.—Males and females; February 27, 1937.

Type specimens.—Alcoholic; imagines extruded from mature pupæ, and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This midge is very similar to *S.* (*O.*) *kanii* in the structures of imagines. The allied species, however, is distinctly different in the presence af the anal point of the male hypopygium. The immature forms of the present species, especially the pupæ, are highly characteristic in the structures of the abdominal terga, being very easily distinguished from all other known species.

SPANIOTOMA (ORTHOCLADIUS) TENTORIOLA sp. nov.

This species is commonly found in rapid clear streams. The young larvæ are not found in nest cases, free-living on the surface of stones, and the old prepupal and pupal forms are always found in white cocoonlike nest cases.

Male.—Imago taken out from mature pupa 2.7 to 3 millimeters long, almost entirely black. Head with eyes bare; antenna 14-segmented, with antennal ratio about 1.3. Thorax with scutellum brown. Legs without tarsal spurs; pulvilli large; tibial spurs of middle leg two, equally very small; ultimate tarsal segments of all legs slightly compressed laterally; claws finely bifid at tip. Relative lengths of segments of foreleg 11.3 : 13.1 : 11.2 : 7.6 : 5 : 3.5 : 2.3, those of hind leg 13.2 : 16 : 8.9 : 6.3 : 4.2 : 2.4 : 2. Squama of wing fringed with several distinct setæ; fMCu far beyond r-m; R_{2+3} separately ending from R_1 and R_{4+5}; 1A extending far beyond fMCu. Hypopygium (Plate 2, fig. 37) without anal point; coxite swollen ventrad on its basal half, with a mesal triangular lobe; style slender, with a distinct canal on its mesal side, a small thickened ridge only at distal part.

Female.—Imago extruded from mature pupa about 2.8 to 3.2 millimeters long, uniformly dark brown. Head with antenna 6-segmented (12 : 28 : 17.5 : 21 : 23 : 36), with two apical setæ; intermediate flagellar segments with distinct neck region and two short, strong, trichoid sensillæ. Proportional lengths of segments of fore and hind legs as follows: 11.6 : 14.4 : 10.5 : 7.5 : 5.5 : 2.9 : 2.3 and 14.8 : 17.5 : 8.4 : 5.7 : 3.8 : 2.1 : 2.2, respectively. Ninth sternum (Plate 3, fig. 58) widely subdivided into small hemisternites found at bases of cerci; cercus (Plate 3, fig. 57) somewhat triangular, with a highly setigerous ventral angle; spermathecæ (Plate 3, fig. 59) pear-shaped, brown on apical swollen area, hyaline on basal area, with dark short neck part. Other structures mainly as in male.

Pupa.—Male 3 to 3.2 millimeters long, female 3 to 3.5. Exuviæ dark; head and thorax black; abdominal terga darkly clouded uniformly. Head without frontal tubercles. Thoracic

respiratory organ (Plate 3, fig. 71) hyaline and swollen on basal half, dark, slender and tapering on distal half. Abdominal structures closely resembling those of *S.* (*Eukiefferiella*) *clypeata* Kieffer reported by Dr. A. Thienemann.(12) Chætotaxy: One pair of long setæ (*e*) and four pairs of shorter setæ (*a*, *b*, *c*, and *d*) on dorsal side; two pairs of longer setæ (*i* and *l*) and two pairs of shorter setæ (*j* and *k*) on ventral side; two small setæ (*g*), two minute setæ (*n*) and a spinulous minute papilla at position of setæ *h* on either lateral side; lateral spinulose papillæ present on five segments from second to sixth; setæ *a* and *e* of first tergum and setæ *e* of eighth tergum very long; eighth segment with only two pairs of tergal setæ *e* and *d*, one pair of sternal setæ *l*, two lateral setæ *n*, and two very strong black bristles near *l* setæ on either side. Second to eighth terga each with a caudal transverse ridge of small black spines, these spines arranged in a single line on dark area; terga from third to seventh segment with a number of smaller spines on either lateral side of the spinose ridges. Third to fifth terga each with several black hooklets arranged in a short line just caudad of spinose ridge at either side (Plate 3, fig. 81). Ultimate segment with three long black setæ on caudal end of either lateral tergal lobe; genital sheaths (Plate 4, fig. 94) extending caudad just beyond ends of tergal lobes in male, sheaths very short and hardly visible between bases of tergal lobes in female.

Larva.—Body slender, about 3.2 to 3.5 millimeters long, purplish black. Head conical, elongated, dark brown; eye spots each consisting of a large and a small black pigment mass on a pale, large, oval area. Labrum epipharynx closely similar to that of *Cardiocladius capucinus* Zetterstedt; mandible with four teeth on cutting edge, four minute teeth on molar edge, two simple setæ on base of mesal side; maxilla (Plate 4, fig. 126) with many hyaline trichoid appendages on distal margin; mentum (Plate 5, fig. 133) with a very broad median tooth, five smaller teeth on either side, a pair of simple basal setæ; hypopharynx (Plate 5, fig. 143) with comparatively less trichoid projections on distal margin, median lobe with one pair of comblike and one pair of needlelike projections. Antenna (Plate 4, fig. 99) 5-segmented, mainly brown, distal two segments hyaline. Anterior pseudopod with various serrulate claws (Plate 5, fig. 152), basal, small, strongly serrulate claws arranged into five transverse lines, distal long, slightly serrulate claws arranged into

about three lines; posterior pseudopod with fifteen strong, simple claws; caudal tuft of setæ consisting of seven long, black setæ on a cylindrical chitinized ring; anal gills, dorsal pair short, oval, and ventral pair long, cylindrical.

Nest case.—Larvæ free-living. Pupal nest case closely similar to that of *Cardiocladius fuscus* Kieffer, white, oval, built in a small concavity on stone, about 3.5 millimeters long and 2 wide.

Habitat.—Rapid stream; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; March 25, 1936.

Allotopotype.—Female; March 25, 1936.

Paratopotypes.—Males and females; March 25, 1936.

Type specimens.—Alcoholic; imagines extruded from mature pupæ, pupæ, and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This species resembles *S.* (*O.*) *virtunensis* Goetghebuer in the coloration of both sexes and in the structure of the male hypopygium. The latter species differs, however, from the present midge in that the halteres are white, the male antennal ratio is about 1, and the first tarsal segment of the foreleg is about half as long as the tibia.

SPANIOTOMA (ORTHOCLADIUS) SUSPENSA sp. nov.

The immature forms of the present species are common in a mountain stream at Kibune, Kyoto.

Male.—Body about 4 to 4.2 millimeters long, almost entirely black; haltere with stem black, knob white. Head with eyes bare. Antenna 14-segmented; antennal ratio 1.5 to 1.7. Palpus with four distinct segments (5: 10: 11: 16). Thorax with pleural membranes yellow, scutum with brownish areas near wing bases. Legs with tarsal spurs on two proximal segments of middle and hind legs; empodium comparatively short; no pulvilli. Proportional lengths of segments of fore and hind legs 75: 84: 58: 37: 25: 17: 12 and 91: 95: 54: 34: 25: 17: 12, respectively. Wing (Plate 1, fig. 15) with fMCu under fR. Abdominal terga dark brown, with a black median stripe; pale triangular area of first tergum not reaching caudal margin of segment. Hypopygium (Plate 2, fig. 38) similar to that in *S.* (*O.*) *kanii*, with a long, thickly spinulose, anal point.

Female.—Body about 4.5 millimeters long, extensively black. Antenna 6-segmented (3 : 6 : 4 : 3.8 : 4.1 : 9.5), with two short preapical setæ. Scutum somewhat yellowish at shoulder parts and lateral sides; scutellum dark brown. Abdominal terga black,

narrowly yellow along caudal margin of each tergum; sterna yellow, with two dark lateral stripes and a median dark cloud. Relative lengths of segments of fore and hind legs 61 : 69 : 47 : 28 : 22 : 16 : 10 and 72 : 76 : 42 : 26 : 21 : 14.5 : 11, respectively. Cercus (Plate 3, fig. 63) black, with prominent ventral lobe; spermatheca (Plate 3, fig. 64) almost spherical, hyaline, dark brown only at apical part, with curved neck region. Other structures mainly as in male.

Pupa.—Male about 4 millimeters long, female 5; exuviæ hyaline. Head, thorax, and abdominal end dark; abdominal tergum extensively finely spinulose, with a large dark cloud; sternum finely spinulose on anterior part, with a narrow dark band along anterior margin. Head with a pair of minute papillæ on clypeal region, an isolated seta on either general region; labral sheath black on distal margin, with a pair of minute apical points. Thoracic respiratory organ (Plate 3, fig. 70) white, tubular. Chætotaxy of abdominal segments: Five pairs of minute setæ (*a, b, c, d,* and *e*) on tergum, four pairs of minute setæ (*i, j, k,* and *e*) on sternum, three setæ (*g, n,* and *o*) on either lateral side; often ventral setæ *j* or *k* double, sometimes atrophied; ultimate tergum with two caudal lobes which are more widely separated in male than in female, with one pair of anterior setæ on lateral side and one pair of minute setæ on mesal margin of caudal incision. Abdominal terga with characteristic spinose black patches (Plate 3, fig. 80) ; second to fifth terga each with a small oval patch on caudomesal ridge, spines on this patch directed cephalad; third to eighth terga each with a larger oval patch on cephalomesal part, spines on this patch directed caudad; third to seventh terga each with a pair of very finely spinulose ridges on caudal margin, these ridges somewhat obscure in third segment. Genital sheaths in male extending caudad far beyond caudal lobes of ultimate tergum, in female ending before caudal ends of tergal lobes (Plate 3, fig. 85).

Larva.—Body about 6 to 7 millimeters long, almost entirely dark green in life. Head yellowish brown or brown, with a pair of oval dark clouds on lateral sides before eye spots, a small dark cloud on clypeal region; eye spot rather variable, usually consisting of two small spherical masses of pigment and sometimes of a single reniform mass of pigment. Antenna (Plate 4, fig. 100) short, 5-segmented; first segment with a large hyaline and a short dark sensory projection; second segment with an apical visorlike projection. Labrum (Plate 4, fig. 118) with a pair of unequally bifurcate distomesal appendages which are not pro-

vided with a common basal plate; epipharynx (Plate 4, fig. 118) with three large mesal teeth between U-sclerite, besides eight pairs of lateral teeth; premandible (Plate 4, fig. 118) strongly angulated; mandible with four small cutting teeth and a long apical tooth; brustia minutely serrulate. Maxilla (Plate 4, fig. 122) without marginal spines on outer lobe, with many dark strong spines on mesal lobe. Mentum (Plate 5, fig. 135) with a very broad mesal tooth and about eight small teeth on either lateral side, basal setæ bifid. Hypopharynx (Plate 5, fig. 145) thickly fringed with strong brown spines on lateral sides; median lobe provided with five or six pairs of yellow spatulate projections; dorsal wall with many small, dark-brown, scalelike projections. Anterior pseudopod with numerous yellow claws, these claws arranged in about six or seven transverse lines; those arranged on basal four or five lines distinctly pectinate and those of distal two lines very long, almost simple (Plate 5, fig. 151). Posterior pseudopod with sixteen long black claws. Caudal tuft of setæ consisting of six long black setæ on small fleshy tubercle, latter with a minute chitinized plate on caudal side. Anal gills equally oval and short.

Nest case.—Larval nest case cylindrical, about 20 to 37 millimeters long, 2.6 to 3.5 millimeters in diameter, fixed on stone at one end, thickly covered with sedentary diatoms and appearing entirely green. Pupal nest case similar in size to larval nest case, with an oval pupal chamber at free end; pupal chamber somewhat pointed at distal end, with one respiratory opening at either end of chamber, about 7 millimeters long and 3.2 wide.

Habitat.—Mountain stream; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; March 25, 1936.

Allotopotype.—Female; March 25, 1936.

Paratopotypes.—Males and females; March 25, 1936.

Type specimens.—Alcoholic imagines, pupæ, and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

The immature forms are somewhat allied to *S.* (*O.*) *rivulorum* Kieffer, reported by Dr. A. Potthast,(7) but in the allied species the pupa carries imbricate tubular respiratory organs, posterior tergal spinose patches that are elongate and concave cephalad, and spinose complete ridges, each of which consists of a single line of spines, along caudal margins of fourth to sixth terga. The imagines are somewhat related to *S.* (*O.*) *rubicunda* Meigen and *S.* (*O.*) *nivium* Kieffer; they are, however, different in the structures of the male ultimate tergum. In the latter species, more-

over, the lateral sides of the thorax and abdomen are somewhat white and the relative length of the foretibia and first tarsal segment is about 15: 10, in this respect differing from the present fly.

SPANIOTOMA (ORTHOCLADIUS) SAXOSA sp. nov.

This species is common on stones in a rapid stream in winter.

Male.—Body about 3.5 millimeters long, almost entirely black; pseudosutural areas somewhat dark brown. Head with eyes bare; antenna 14-segmented; antennal ratio about 1.3. Middle and hind legs with tarsal spurs on two proximal segments; empodium comparatively short; relative lengths of segments of foreleg about 15: 17.6: 14: 9.4: 7.3: 5.3: 3.8, of hind leg 21.7: 22.6: 13.8: 8.9: 6.4: 4.6: 3.7. Hypopygium with setigerous anal point; coxite with a small mesal lobe; style (Plate 2, fig. 39) with a prominent triangular preapical ridge.

Female.—Body about 3.4 to 3.8 millimeters long, yellow in ground color, with three distinctly separated black scutal vittæ. Head black, with antenna 6-segmented (21.5: 36.8: 19.8: 21.3: 21.8: 58.5); ultimate antennal segment with an apical seta, pubescent on distal two-thirds with hyaline hairs. Palpus with four distinct segments (23: 51: 46: 72). Thorax extensively yellow; scutum with three black vittæ, median vitta sometimes separated; scutellum brown; postscutellum black; pronotum with a brown cloud at either lateral side; pleural side very extensively yellow, sclerites brown, a black spot on either side near wing base; sternepisternum with a black stripe which is narrowly separated from the black sternal area by a yellow stripe. Halteres yellow. Legs with coxæ black, trochanters and bases of femora yellow; other parts black; tarsal spurs present on three proximal segments of middle and hind legs; leg ratio of foreleg about 0.77 (0.75 to 0.8). Wing (Plate 1, fig. 16) dark by transmitted light, yellow on basal area; fMCu under fR; Cu_1 sinuous at tip. Abdomen dark brown on dorsal side, brown on ventral side, narrowly yellowish brown on caudal margin of each tergum; ultimate segment darker; cerci (Plate 3, fig. 62) with long ventral lobe, yellowish brown; spermathecæ oval, mainly brown, somewhat yellow on basal third or more, black on neck region.

Pupa.—Body about 3.5 to 3.8 millimeters long in male and 4 in female, mainly dark brown, without swimming hairs and lateral expansions. Head with two distinct frontal tubercles. Thoracic respiratory organs (Plate 3, fig. 61) white, oval; paratergal margin with a prominent tubercular lobe before wing

base. First to third or fourth abdominal segments each with a papilliform swelling on caudal part of either lateral side; second to ninth terga each with a finely spinulose area on cephalic half; eighth tergum with a pair of minute tubercles on caudal margin; second to sixth abdominal sterna each with a finely spinulose area on caudal half; seventh and eighth sterna each with a pair of finely spinulose small areas along cephalic margin; sixth and eighth sterna each with a pair of thickly spinose dark areas on caudolateral part. Chætotaxy of abdomen: Tergum with five pairs of small setæ *a, b, c, d,* and *e,* sternum with four pairs of minute setæ *i, j, k,* and *l,* lateral side with two small dorsal *g* and *h* and a ventral *n* seta on middle part; eighth segment with only tergal *e* setæ, sternal *l* setæ, and somewhat with double *n* setæ; ultimate segment without setæ. Characteristic arrangement of spinose ridges and patches as follows: Second and third terga each with a distinct spinose ridge along caudal margin, about one-third as long as caudal margin and carrying numerous black spines grown cephalad; fourth and fifth terga (Plate 3, fig. 77) each with a smaller black, spinulose patch just along cephalic margin of the spinose ridge, which is similar in structure to that of the preceding segment, this spinulose patch carrying numerous minute black spinules which are all grown caudad; sixth and seventh terga each with a larger caudal spinulose patch which is similar in structure to that of the two preceding segments but larger, being about one-third or more of caudal margin of segment. Ultimate segment (Plate 3, fig. 89) with a pair of small black tergal lobes; genital sheaths of male very long, straight, extending caudad beyond caudal lobes of ultimate tergum; those of female very short but visible in dorsal aspect, being slightly beyond caudal lobes.

Larva.—Body about 4.5 millimeters long, greenish brown in ground color in life. Head brown, lateral and ventral side extensively yellow. Antenna (Plate 4, fig. 97) mainly brown; ultimate segment hyaline. Labrum (Plate 4, fig. 117) with paired distomesal appendages equally bifurcate; epipharynx (Plate 4, fig. 117) with five large hooks between arms of U-shaped chitinization, a large oval proximal plate; premandible (Plate 4, fig. 109) distinctly spatulate, and with a pointed tip. Mandible with four small cutting teeth, two plumose hairs at base. Maxilla (Plate 4, fig. 125) fringed thickly with scalelike and strong trichoid spines; palpus flattened disclike. Mentum (Plate 5, fig. 134) with three large median teeth, a pair of large lateral and four pairs of small pointed lateral teeth. Hypo-

pharynx (Plate 5, fig. 146) not thickly fringed, with only two strong lateral spines and several sensillæ on either side; median lobe branched into four pairs of trichoid projections of which one pair are finely serrulate. Anterior pseudopod with various claws (Plate 5, fig. 153) which are golden yellow and arranged into about fifteen transverse lines; claws of basal four lines very slender, small, simple; those of next six lines variously serrate; those of next three lines long, slender, serrate only on apical one-third or more; those of two distal lines very long, slender, simple. Posterior pseudopod with sixteen large, black, simple claws. Caudal tuft of setæ consisting of five short setæ grown on small fleshy tubercle. Dorsal pair of anal gills short, oval; ventral pair slender, tubular.

Nest case.—Larval nest cases clearly hyaline, gelatinous, somewhat irregular, closely applied to stones along small crevices on surface, about 10 to 16 millimeters long and 3 to 5 wide in full-grown larvæ. Pupal nest cases also clearly hyaline and gelatinous, somewhat oval, closely adhering on stones with short stems; chamber part about 7 to 10 millimeters long and 4 to 6 wide; stem part about 3 millimeters long.

Habitat.—Rapid stream; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; March 25, 1936.

Allotopotype.—Female; March 25, 1936.

Paratopotypes.—Males and females; March 25, 1936.

Type specimens.—Alcoholic imagines, pupæ, and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

The present species is allied to the following species: *S.* (*O.*) *rubicunda* Meigen, *S.* (*O.*) *thienemanni* Kieffer, and *S.* (*O.*) *oblidens* Walker. These allied species, however, may be easily distinguished from the present species in the following points: In *S. rubicunda* the male hypopygium is provided with a bare ultimate tergum, and the ridges of the styles are slightly developed; in *S. thienemanni* the two distal tarsal segments of all legs are subequal in length, the male antennal ratio is about 2, and the male hypopygium is provided with a very large mesal lobe of the coxite; in *S. oblidens* the male antennal ratio is about 2 and the style of the hypopygium carries a very slightly developed ridge. The immature forms of the present species closely resemble those of *S. thienemanni;* the pupa of the latter, however, is not provided with the spinose ridge on the second tergum. Similar pupal nest cases are also known in the cases of

S. thienemanni Kieffer, *S. rivicola* Kieffer, and *S. minuta* Zetterstedt.

SPANIOTOMA (ORTHOCLADIUS) FILAMENTOSA sp. nov.

This species is commonly found in a rapid stream in Kyoto. The immature forms build their nest cases on stones of clear streams.

Male.—Body about 4 millimeters long, almost entirely black; scutellum somewhat dark brown; haltere with white knob. Head with eyes bare; antenna 14-segmented, with antennal ratio about 1.9. Legs without pulvilli; middle and hind legs with tarsal spurs on two proximal segments; leg ratio about 0.73 to 0.75 in foreleg and 0.58 to 0.62 in hind leg. Wing (Plate 1, fig. 17) with costa slightly produced beyond end of R_{4+5}, R_{2+3} ending before middle between ends of R_1 and R_{4+5}, R_1 about half as long as R_{4+5}, fMCu under crossvein. Coxite of hypopygium very long, with a prominent basal lobe on mesal side; style (Plate 2, fig. 40) flattened, with a preapical ridge slightly developed; ultimate tergum without setæ; anal point long, pubescent, with strong scattered spinules.

Female.—Body about 4.2 millimeters long. Head entirely dark brown; antenna 6-segmented (25:38:24:23:21:68); its ultimate segment entirely pubescent with small hyaline hairs, with a long and a small apical seta, subequal in length to three preceding segments taken together. Thorax extensively yellow at side; pronotum brown, somewhat dark at side; scutum brown, with a dark-brown median vitta and two black lateral vittæ on brown ground color, these three vittæ subconfluent; scutellum brown; postscutellum black; pleural sclerites entirely black. Haltere with white knob. Wing with basal part yellow, R_1 longer than half of R_{4+5}, end of R_{2+3} slightly separated from end of R_1. Abdominal terga entirely brown. Cercus (Plate 3, fig. 65) pale brown; ultimate sternum subdivided into hemisternites which are very widely separated, highly setigerous, projecting caudoventrad; spermathecæ somewhat oval, mainly dark brown, with basal part brown. Other structures largely as in male.

Pupa.—Body about 4.5 to 5 millimeters long; exuviæ extensively dark; abdominal dorsal side extensively dark; caudal area of each tergum hyaline. Head with vertex, labrum, compound eyes, and antennal bases dark brown, other parts pale brown, without frontal tubercles, with three pairs of small setæ: One pair on vertex between antennal bases and two setæ on either

genal part. Thorax with several black setæ and three small papilliform tubercles on either side. Thoracic respiratory organs (Plate 3, fig. 72) white, filiform, rarely slightly branched only at tip. Abdomen with lateral expansions on four caudal segments, without lateral swimming hairs; segments from second to seventh finely spinulose in varying extent on both dorsal and ventral sides; first, eighth, and ninth segments without spinulose areas. Chætotaxy as follows: Tergum typically with five pairs of setæ (*a, b, c, d,* and *e*), sternum also with five pairs of setæ (*i, j, k, l,* and *m*), either lateral side with two *n* setæ and one *o* seta; *a, e, i,* and *j* setæ longer than others; *d* setæ often absent on first three segments; first segment with *g* seta on lateral side and only one pair of *i* setæ on ventral side; eighth segment with only one pair of *e* setæ on dorsal side, one pair of *m* setæ on ventral side, and single *g, n,* and *o* setæ and double *h* setæ on either lateral side; these setæ of eighth segment stronger than in other segments; ultimate segment with only three very strong black setæ at caudal end of each tergal lobe. Characteristic arrangement of spinose ridges (Plate 3, figs. 79 and 82) as follows: Second tergum with a large caudal ridge which is about half as long as caudal margin of segment and composed of small black hooklets arranged into about three lines; these hooklets curved dorsocephalad; each hooklet with a minute tooth at shoulder part; third to fifth terga each with a long caudal ridge which is almost as long as entire caudal margin of segment and composed of small black spines arranged into about three lines; these spines extending straight dorsocephalad; sixth tergum without special spinose ridge, its mesal spinose area with strong spines on caudal part along margin; fourth to sixth sterna each with a pair of small spinulose areas on caudolateral parts. Ultimate segment (Plate 4, fig. 93) of male with genital sheaths extending straight caudad, beyond tergal lobes; female genital sheaths almost as long as tergal lobes.

Larva.—Body about 6 to 7 millimeters long in full-grown stage, yellowish green. Head brown, with pale round areas around eye spots. Antenna (Plate 4, fig. 101) 5-segmented. Labrum with a pair of unequally bifurcate distomesal appendages, one very strong simple appendage and many simple trichoid appendages along distal margin of either lateral side; epipharynx with a large median hooklike tooth, nine lateral hooklike teeth of various sizes, and two lateral simple spines between U-shaped thickening, a small basal thickened plate (Plate 4, figs.

108 and 119). Mandible comparatively slender, with four cutting teeth. Maxilla (Plate 5, fig. 127) with a tuft of strong spines on mesal lobe, many scalelike marginal spines on both lobes. Mentum (Plate 5, fig. 136) with a very broad median tooth, truncate apically, first lateral teeth broad, other five pairs of lateral teeth pointed, basal setæ simple, single. Hypopharynx (Plate 5, fig. 147) thickly fringed with long spines, with a pair of very strong preapical spines, median lobe with a pair of minute dorsal papillæ, a pair of trichoid projections and many flattened projections; dorsal wall distinctly imbricate, with many small comblike scales. Anterior pseudopod with numerous claws of various sizes which are arranged into about fifteen transverse lines; claws of two basal lines minute, simple; those of next eight lines variously serrate; those of following four lines elongate, finely serrulate basally and roughly serrate apically; those of distal line very slender, finely serrulate only on basal part (Plate 5, fig. 158). Posterior pseudopod with sixteen slender, simple claws. Caudal tuft to setæ composed of six long setæ grown on small fleshy papilla. Four anal gills similar in shape and size, elongate, tubular, somewhat swollen on basal half.

Nest case.—Both pupal and larval nest cases built on stones with muddy debris, somewhat tubular, closely applied with entire length on stones along crevices; cases of full-grown larvæ and pupæ about 10 to 12 millimeters long and about 3 to 4 millimeters wide.

Habitat.—Torrential stream; Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; March 25, 1936.

Allotopotype.—Female; March 25, 1936.

Paratopotypes.—Males and females; March 25, 1936.

Type specimens.—Alcoholic imagines, pupæ, and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

This torrential midge somewhat resembles *S.* (*O.*) *thienemanni* Kieffer and *S.* (*O.*) *nivium* Kieffer, but may be distinguished from them by the following characters of the male: In the first allied species, antennal ratio about 2, two scutal stripes between vittæ dull yellow, and scutal vittæ less shiny. In the second allied species antennal ratio about 1.5, pleural side with white clouds, foreleg ratio about 0.67, costal vein of wing not produced beyond end of R_{4+5}, and lateral sides of abdomen white.

SPANIOTOMA (TRICHOCLADIUS) INTERMEDIA sp. nov.

The present species was often collected in mountain streams in winter. The prepupal and pupal forms are found in hyaline gelatinous nest cases closely applied to stones, while the younger larvæ are free-living, actively crawling on the surface of stones.

Male.—Body about 3 millimeters long, entirely black. Head with eyes pubescent. Antenna 14-segmented; antennal ratio about 1.1. Thorax with very minute humeral pits. Legs with tarsal spurs on two proximal segments of middle and hind legs; no pulvilli; proportional lengths of segments of legs 16.8 : 21.7 : 15.5 : 9.4 : 7.5 : 5.6 : 3.8 in foreleg and 21.7 : 25.5 : 13.1 : 8.4 : 6.8 : 4.6 : 3.8 in hind leg. Wing with costal vein very slightly produced beyond end of R_{4+5}, R_{2+3} ending at one-fourth between ends of R_1 and R_{4+5}, fMCu slightly beyond fR. Hypopygium with ultimate tergum slightly setigerous at caudolateral margins; anal point roughly spinose with short strong spines; coxite slender, slightly swelling mesad, with a basal triangular lobe; style (Plate 2, fig. 41) with a large dorsal thickened ridge.

Female.—Body about 3.5 millimeters long, color as in *S.* (*O.*) *saxosa* or more yellowish. Antenna 6-segmented (18 : 32 : 22 : 20 : 24 : 42), with two preapical setæ, scape yellow. Proportional lengths of segments of fore and hind legs: 18.4 : 23.5 : 16.5 : 10.9 : 8.2 : 6 : 3.8 and 24.6 : 29.7 : 15.1 : 9.2 : 7.5 : 4.7 : 3.8, respectively. Cercus (Plate 3, fig. 60) with large ventral lobe; spermathecæ as in *S.* (*O.*) *saxosa*. Other structures mainly as in male.

Pupa.—Body, male, about 3.5 millimeters long; female, 4. Exuviæ with head, thorax, and ultimate tergum yellowish brown; abdominal dorsal side yellow, ventral side hyaline. Head with paired frontal tubercles pointed in male and blunt in female, without distinct setæ. Thorax without respiratory organs. Abdomen without lateral swimming hairs and expansions; third to eighth terga in male and third to ninth in female spinulose on cephalomesal area, sterna from second to seventh very finely spinulose on anterior area. Abdominal chætotaxy as follows: Tergum typically with five pairs of small setæ (*a*, *b*, *c*, *d*, and *e*), sternum with four pairs of minute setæ (*i*, *j*, *k*, and *l*), either lateral side with a dorsal *g* and two ventral *n* and *o* setæ; eighth segment with only two pairs of dorsal *e* and *g* setæ; ultimate segment without setæ. Characteristic arrangement of spinose patches as follows: Third to eighth terga each with a black spinose patch along caudal margin; these spinose patches consisting of black spines, about two-fifths as long as caudal

margin of segment; spines of patches arranged in about five transverse lines and extending straight caudad (Plate 3, fig 74). Genital sheaths of male very long, distinctly upcurved, of female very short but visible in dorsal aspect between tergal lobes (Plate 3, fig. 84).

Larva.—Body about 5.5 to 6.2 millimeters long in full-grown stage, largely purplish black; thoracic segments somewhat paler. Head black, with black double eye spots on yellow oval areas. Antenna (Plate 4, fig. 102) 5-segmented, with a large trichoid sensilla which is slightly shorter than four distal segments put together, minute ultimate segment hyaline, other segments black. Labrum with a pair of equally bifurcate distomesal appendages on a common cordiform plate, other appendages all simple and trichoid. Epipharynx closely similar to that of *S.* (*O.*) *filamentosa*, but each lateral group of hooklike teeth composed of only four teeth and basal plate elongate, differing from teeth in *S. filamentosa.* Mandible with five cutting teeth, a plumose basal seta on mesal edge. Maxilla (Plate 5, fig. 129) with disclike palpus, fringed with many hyaline trichoid spines. Mentum (Plate 5, fig. 137) with median tooth broad, slightly subdivided apically; first lateral teeth broad, blunt apically; other five lateral pairs smaller, pointed; basal setæ simple. Hypopharynx (Plate 5, fig. 148) fringed with simple spines on lateral side, with two strong simple spines and one plumose spine on either distolateral margin, median lobe branched into four pairs of serrulate projections. Anterior pseudopod with various yellow claws which are arranged into about twenty transverse lines; claws of four basal lines simple, those of thirteen middle lines short, pectinate, and those of three distal lines slender, pectinate only on apical part (Plate 5, fig. 155). Posterior pseudopod with sixteen claws which are large, black, strongly curved, and simple. Setæ of caudal tuft six, very long, grown on a small fleshy common tubercle. Anal gills with dorsal pair elongate and oval; ventral pair longer, constricted at middle, basal part swollen distinctly.

Nest case.—Cases built in prepupal stage, hyaline, gelatinous, oval, about 8 to 10 millimeters long and 5 wide.

Habitat.—Clear mountain stream: Honshu, Japan.

Holotype.—Male; Kibune, Kyoto; March 25, 1936.

Allotopotype.—Female; March 25, 1936.

Paratopotypes.—Males and females extruded from mature pupæ; March 25, 1936.

Type specimens.—Alcoholic imagines, pupæ, and larvæ; deposited in the entomological laboratory, Kyoto Imperial University; collected by M. Tokunaga.

The pupa of the present species is distinctly different from other known *Trichocladius* pupæ in the absence of anal bristles of the ultimate tergal lobes. The imago is intermediate in type between two groups, *Trichocladius* and *Acricotopus;* both sexes, highly differing from known members of *Trichocladius,* are not provided with pulvilli; the male, differing from known species of *Acricotopus,* is provided with a distinct anal point, and the female carries 6-segmented antennæ.

CHIRONOMINÆ

CHIRONOMUS (CHIRONOMUS) CRASSIFORCEPS Kieffer.

Tendipes crassiforceps KIEFFER, Ann. Mus. Nat. Hung. 14 (1916) 111, 112.

The present specimens of this species were collected from a hot spring, about 38°C. in temperature, at Sozan, Taihoku.

Male.—Body about 3.5 to 5.2 millimeters long; thoracic ground color white; abdomen brown. Head and mouth parts uniformly brown, with paired frontal tubercles. Antenna 12-segmented; antennal ratio about 1.6. Thorax with four distinct scutal vittæ on white scutum, median vittæ brown, lateral vittæ dark brown; scutellum pale brown; postscutellum black; pleural sclerites mainly brown, dorsal part of sternepisternum white. Legs entirely brown, with large brown pulvilli; foretibia with a blunt apical projection; proportional lengths of segments of foreleg 78 : 65 : 95 : 45 : 38 : 35 : 18, of middle leg 78 : 74 : 32 : 19 : 16 : 11 : 10, and of hind leg 90 : 82 : 45 : 25 : 24 : 14 : 11. Wing about 2.7 millimeters long, with veins yellowish brown, cross-vein brown; fMCu beyond fR, 1A extending beyond fMCu. Haltere white. Abdomen and hypopygium brown; eighth tergum somewhat pale brown on caudal half. Hypopygium (Plate 2, fig. 42) with ultimate tergum setigerous; anal point thickened, not trilobate; style very large, oval in lateral aspect, with numerous short, strong spines on mesal side of apical half; dorsal appendage long, slender, bare; ventral appendage slender, almost as long as style, without special apical recurved setæ.

Female.—Body about 3.4 to 4.5 millimeters long. Antenna 6-segmented (20 : 39 : 32 : 33 : 28 : 61), scape yellow, flagellum pale brown; intermediate flagellar segments each with a distinct neck region; ultimate segment with only one preapical seta.

Palpus 5-segmented (13: 15: 31: 45: 73). Legs with proportional lengths of segments 56: 44: 70: 34: 28: 26: 14 in foreleg, 56 : 57 : 26 : 14 : 12 : 9 : 7 in middle leg, and 65 : 64 : 40 : 22 : 20: 10.5: 9 in hind leg. Wing (Plate 1, fig. 18) broad, slightly constricted on caudal margin at end of Cu_1. Other structures mainly as in male.

Pupa.—Body about 5 to 6 millimeters long. Head with a pair of distinct frontal tubercles, each of which carries a small apical seta. Thoracic respiratory organ as in *C.* (*C.*) *dorsalis* Meigen but smaller. Second abdominal tergum with a caudal ridge of hooklets, these hooklets each with one or two minute teeth at shoulder part; fifth to eighth segments each with a lateral lamella and four long swimming hairs on either lateral side; eighth segment with a pair of thin simple spines on caudolateral angles; ultimate segment with a pair of lateral semicircular lamellæ which are very thickly fringed with short setæ arranged into two or three lines.

Larva.—Body about 7 millimeters long, blood-red in life. Head yellowish white, black only on eye spots, mentum, apical parts of mandibles, and occipital margin; eye spot consisting of three very widely separated masses of pigment, of which the dorsal one is large, reniform, the ventral one large and distinctly constricted, the caudal one very small. Antenna (Plate 4, fig. 98) 5-segmented; first segment about twice as long as four following segments taken together. Labrum epipharynx with appendages closely similar to those of *C.* (*C.*) *dorsalis*, but median plumose appendage of labrum (Plate 4, fig. 111) broad and more strongly pectinate, distomesal comblike appendage of ephipharynx with about twenty teeth. Mandible (Plate 4, fig. 112) with four cutting teeth, molar edge serrulate into three small teeth, with four basal short plumose projections. Maxilla (Plate 5, fig. 128) closely resembling that of *C.* (*C.*) *dorsalis.* Mentum (Plate 5, fig. 138) with three median teeth, of which the lateral pair are small; six pairs of lateral teeth pointed. Hypopharynx (Plate 5, fig. 149) fringed with hyaline, comblike scales on distal margin and with long spines on lateral margins. Anterior pseudopod with numerous simple hairlike claws on ventral side, claws of several distal transverse lines (Plate 5, fig. 159) long, finely serrulate. Posterior pseudopod with sixteen golden-brown simple claws. Eighth abdominal segment with two lateral filaments on either side, of which the caudal filament is longer, but not longer than the segment. Caudal tuft of setæ consisting of

seven long setæ which grow on a small fleshy tubercle. Anal gills equally elongate and tubular.

Habitat.—Hot spring of sulphurous water; Formosa.

Specimens.—Alcoholic males, females, pupæ, and larvæ; Sozan, Taihoku; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

The imagines are somewhat different from the descriptions given by Dr. J. J. Kieffer,(3) the type specimens being said to have the antennal ratio about 2 and the ventral appendage of the male hypopygium to carry long setæ on its apical one-third.

CHIRONOMUS (CHIRONOMUS) ACERBIPHILUS sp. nov.

This species was collected from a pond of highly acidic water, pH about 1.4, at Katanuma.

Male.—Body about 5.5 to 6 millimeters long, ground color black. Antenna 12-segmented; antennal ratio about 2.68. Thorax pruinose. Legs with dark-brown pulvilli; foreleg ratio about 1.2. Haltere dark brown. Wing with black crossvein. Abdomen almost entirely black; terga somewhat paler along caudal margin. Hypopygium (Plate 2, fig. 43) with anal point slender; style with dorsal thickened ridge; dorsal appendage with apical part irregularly serrulate; ventral appendage comparatively short, extending caudad not far beyond anal point.

Female.—Body about 6 millimeters long. Antenna 6-segmented (5 : 8 : 6 : 6 : 7.5 : 18); antennal ratio about 0.67; second segment slightly constricted; intermediate flagellar segments each with a short neck region. Foreleg ratio about 1.24. Spermathecæ two, equal, hyaline, short-oval; cercus (Plate 3, fig. 66) black, somewhat angulated. Other structures mainly as in male.

Habitat.—Acidic water; Honshu, Japan.

Holotype.—Male; Katanuma, Miyagi Prefecture; May, 1937.

Allotopotype.—Female; May, 1937.

Paratopotypes.—Males and females; May, 1937.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. K. Fujimatsu.

This species is very closely allied to *C.* (*C.*) *lugubris* Zetterstedt, but the two are distinguished from each other by difference in the structures of the male hypopygium and by the shape of the female cerci, mentioned above.

TANYTARSUS (MICROPSECTRA) TAIWANUS sp. nov.

This midge was collected at Gokan, Formosa, altitude, about 3,000 meters.

Male.—Body about 4.5 millimeters long, black in ground color. Head almost entirely dark brown, with very small frontal tubercles; antenna dark brown, 14-segmented; antennal ratio about 1.4. Pronotum dark brown; scutum black, slightly shiny; scutellum dark brown; postscutellum black; pleural and sternal sclerites dark brown. Legs dark brown; basal ends of all femora pale brown; pulvilli present, about half as long as claws. Wing (Plate 1, fig. 20) about 3.5 millimeters long, uniformly dark, with macrotrichia on distal one-third. Haltere pale brown. Abdominal terga mainly dark brown, black on caudal margin. Hypopygium (Plate 2, fig. 45) with anal point short, bare; dorsal appendage swollen, setigerous, with a small accessory lobe; ventroproximal appendage pubescent on stem, with flattened setæ on apical part.

Habitat.—Mountain region; Formosa.

Holotype.—Alcoholic male; Gokan, Taichyu Prefecture; August 13, 1936; deposited in the entomological laboratory, Kyoto Imperial University; collected by Dr. R. Takahashi.

This species is somewhat related to *T.* (*M.*) *brunnipes* Zetterstedt and *T.* (*M.*) *fuscus* Meigen; but the former is not provided with pulvilli and the latter is specific, with the antennal ratio about 2.

TANYTARSUS (STEMPELLINA) OKADAI sp. nov.

This small midge was collected from hot spring water, about 36°C. in temperature.

Male.—Body about 1.6 to 1.8 millimeters long, brown in ground color. Head brown, with V-shaped black thickening on vertex; eyes bare; frontoclypeus with about ten setæ; frontal tubercles represented only by blunt swellings of integument. Antenna with scape dark brown, flagellum and plumose hairs brown, 13-segmented, but two distal segments obscurely segmented; ultimate segment shorter than four preceding segments taken together (56 : 63.5) antennal ratio about 0.35 to 0.4. Palpus brown, 5-segmented (8: 12.5: 34: 29: 40). Thorax with scutum reddish brown, lateral vittæ black, median vittæ reddish brown, these four vittæ separated by a middorsal line of about ten pale setigerous dots and two lateral lines of about five pale dots, shoulder parts yellowish brown; scutellum reddish brown and somewhat paler than scutum, with two long median and two short lateral setæ; postscutellum dark brown; pleural and sternal sclerites brown; pleural membranes yellowish brown. Legs with coxæ brown, other segments pale brown; foretibia with a

fixed apical spine; other tibiæ each with two small separated combs each of which carries one short spur; no pulvilli; no beards; foreleg ratio about 1.5. Wing (Plate 1, fig. 19) cuneiform, pale brown by transmitted light, R_{4+5} ending before level of end of M_{4+5}, fMCu beyond fR; macrotrichia present in cells R_5 and M_2. Haltere yellowish brown. Tergal side of abdomen brown, with pale dots at bases of setæ; sternal side yellowish brown. Hypopygium (Plate 2, fig. 44) with anal point short, setigerous and pubescent; style slender; dorsal appendage fusiform, setigerous, with a slender accessory lobe; ventroproximal appendage slender, with simple setæ.

Habitat.—Hot spring water; Honshu, Japan.

Holotype.—Male; Tsubame-Onsen, Niigata Prefecture; July 19, 1937.

Paratopotypes.—Males; July 19, 1937.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Prof. Dr. Y. Okada and Mr. S. Ito.

This species is somewhat allied to *T.* (*S.*) *cuneipennis* Edwards; in the allied species, however, the foreleg ratio is about 1.6, vein R_1 is shorter than half of R_{4+5}, the marginal fringe of wing is very long, and the wing margin is more angulated at end of Cu_1.

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ILLUSTRATIONS

[Drawings by Miss Hisayo Taniguti and M. Tokunaga.]

PLATE 1

FIG. 1. *Pentaneura esakii* sp. nov.; male, wing.
2. *Pentaneura esakii* sp. nov.; female, wing.
3. *Heptagyia brevitarsis* (Tokunaga); female, wing.
4. *Brillia modesta* Meigen; male, wing.
5. *Brillia japonica* sp. nov.; female, wing.
6. *Metriocnemus* (*Parametriocnemus*) *stylatus* Kieffer; male, wing.
7. *Cardiocladius capucinus* Zetterstedt; male, wing.
8. *Cardiocladius fuscus* Kieffer; female, wing.
9. *Spaniotoma* (*Smittia*) *nudipennis* Goetghebuer; male, wing.
10. *Spaniotoma* (*Smittia*) *niitakana* sp. nov.; male, wing.
11. *Spaniotoma* (*Smittia*) *truncatocaudata* sp. nov.; male, wing.
12. *Spaniotoma* (*Eukiefferiella*) *takahashii* sp. nov.; male, wing.
13. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; male, wing.
14. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; female, wing.
15. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; male, wing.
16. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; female, wing.
17. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; male, wing.
18. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; female, wing.
19. *Tanytarsus* (*Stempellina*) *okadai* sp. nov.; male, wing.
20. *Tanytarsus* (*Micropsectra*) *taiwanus* sp. nov.; male, wing.
21. *Cardiocladius esakii* sp. nov.; female, fourth tarsal segment of hind leg.
22. *Cardiocladius capucinus* Zetterstedt; male, fourth tarsal segment of hind leg.
23. *Cardiocladius fuscus* Kieffer; female, fourth tarsal segment of hind leg.
24. *Metriocnemus stylatus* Kieffer; male, distal part of antenna.

PLATE 2

FIG. 25. *Anatopynia nebulosa* Meigen; male, coxite and style.
26. *Pentaneura esakiana* sp. nov., male, basal projection of coxite.
27. *Pentaneura esakii* sp. nov.; male, coxite and style.
28. *Brillia modesta* Meigen; male, hypopygium.
29. *Brillia japonica* sp. nov.; male, hypopygium.
30. *Metriocnemus* (*Parametriocnemus*) *stylatus* Kieffer; male, hypopygium.
31. *Cardiocladius capucinus* Zetterstedt; male, hypopygium.
32. *Spaniotoma* (*Smittia*) *nudipennis* Goetghebuer; male, hypopygium.
33. *Spaniotoma* (*Smittia*) *niitakana* sp. nov.; male, hypopygium.
34. *Spaniotoma* (*Smittia*) *truncatocaudata* sp. nov.; male, hypopygium.

FIG. 35. *Spaniotoma* (*Eukiefferiella*) *takahashii* sp. nov.; male, hypopygium.
36. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; male, coxite with style and anal point.
37. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; male, coxite and style.
38. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; male, coxite and style.
39. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; male, style.
40. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; male, style.
41. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; male, style.
42. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; male, hypopygium.
43. *Chironomus* (*Chironomus*) *acerbiphilus* sp. nov.; male, hypopygium.
44. *Tanytarsus* (*Stempellina*) *okadai* sp. nov.; male, hypopygium.
45. *Tanytarsus* (*Micropsectra*) *taiwanus* sp. nov.; male, hypopygium.
46. *Heptagyia brevitarsis* (Tokunaga); female, cercus.
47. *Heptagyia brevitarsis* (Tokunaga); female, spermatheca.
48. *Brillia japonica* sp. nov.; female, cercus.
49. *Brillia japonica* sp. nov.; female, spermatheca.
50. *Cardiocladius capucinus* Zetterstedt; female, lateral projection of ninth abdominal segment.
51. *Cardiocladius capucinus* Zetterstedt; female, cercus.
52. *Cardiocladius capucinus* Zetterstedt; female, spermatheca.
53. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; female, cercus.
54. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; female, spermatheca.
55. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; female, spermatheca.

PLATE 3

FIG. 56. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; female, cercus.
57. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; female, cercus.
58. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; female, lateral projection of ninth abdominal segment.
59. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; female, spermatheca.
60. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; female, cercus.
61. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; pupa, respiratory organ.
62. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; female, cercus.
63. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; female, cercus.
64. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; female, spermatheca.
65. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; female, cercus.
66. *Chironomus* (*Chironomus*) *acerbiphilus* sp. nov.; female, cercus.
67. *Anatopynia nebulosa* Meigen; pupa, respiratory organ.
68. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; pupa, respiratory organ.
69. *Heptagyia brevitarsis* (Tokunaga); pupa, respiratory organ.
70. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; pupa, respiratory organ.

FIG. 71. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; pupa, respiratory organ.

72. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; pupa, respiratory organ.

73. *Anatopynia nebulosa* Meigen; pupa, third and seventh abdominal terga.

74. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; pupa, sixth abdominal tergum.

75. *Cardiocladius capucinus* Zetterstedt; pupa, seventh abdominal tergum and sternum.

76. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; pupa, seventh abdominal tergum and sternum.

77. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; pupa, fifth abdominal tergum.

78. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; pupa, fifth abdominal tergum.

79. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; pupa, second abdominal tergum.

80. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; pupa, fourth abdominal tergum.

81. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; pupa, third abdominal tergum.

82. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; pupa, fifth abdominal tergum.

83. *Cardiocladius capucinus* Zetterstedt; male pupa, abdominal end.

84. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; female pupa, abdominal end.

85. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; male pupa, last abdominal tergum.

86. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; female pupa, abdominal end.

87. *Anatopynia nebulosa* Meigen; male pupa, abdominal end.

88. *Heptagyia brevitarsis* (Tokunaga); female pupa, abdominal end.

89. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; female pupa, abdominal end.

90. *Cardiocladius capucinus* Zetterstedt; female pupa, abdominal end.

91. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; male pupa, abdominal end.

PLATE 4

FIG. 92. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; male pupa, abdominal end.

93. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; male pupa, abdominal end.

94. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; male pupa, abdominal end.

95. *Heptagyia brevitarsis* (Tokunaga); larva, antenna.

96. *Cardiocladius capucinus* Zetterstedt; larva, antenna.

97. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, antenna.

98. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, antenna.

FIG. 99. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; larva, antenna.
100. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; larva, antenna.
101. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, antenna.
102. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; larva, antenna.
103. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, antenna.
104. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; larva, antenna.
105. *Cardiocladius capucinus* Zetterstedt; larva, premandible.
106. *Heptagyia brevitarsis* (Tokunaga); larva, premandible.
107. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, premandible.
108. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, premandible.
109. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, premandible.
110. *Heptagyia brevitarsis* (Tokunaga); larva, dorsal side, anterior and posterior parts.
111. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, distomesal appendage of labrum.
112. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, mandible.
113. *Cardiocladius capucinus* Zetterstedt; larva, labrum epipharynx.
114. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; larva, labrum epipharynx.
115. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, epipharynx.
116. *Heptagyia brevitarsis* (Tokunaga); larva, labrum epipharynx.
117. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, labrum epipharynx.
118. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; larva, labrum epipharynx.
119. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, labrum epipharynx.
120. *Heptagyia brevitarsis* (Tokunaga); larva, maxilla.
121. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; larva, maxilla.
122. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; larva, maxilla.
123. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, maxilla.
124. *Cardiocladius capucinus* Zetterstedt; larva, maxilla.
125. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, maxilla.
126. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; larva, maxilla.

PLATE 5

FIG. 127. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, maxilla.
128. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, maxilla.
129. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; larva.
130. *Cardiocladius capucinus* Zetterstedt; larva, mentum.
131. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; larva, mentum.
132. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, mentum.
133. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; larva, mentum.
134. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, mentum.
135. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; larva, mentum.
136. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, mentum.
137. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; larva, mentum.
138. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, mentum.
139. *Heptagyia brevitarsis* (Tokunaga); larva, mentum.

FIG. 140. *Heptagyia brevitarsis* (Tokunaga); larva, hypopharynx.
141. *Cardiocladius capucinus* Zetterstedt; larva, hypopharynx.
142. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; larva, hypopharynx.
143. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; larva, hypopharynx.
144. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, hypopharynx.
145. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; larva, hypopharynx.
146. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, hypopharynx.
147. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, hypopharynx.
148. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; larva, hypopharynx.
149. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, hypopharynx.
150. *Heptagyia brevitarsis* (Tokunaga); larva, claws of posterior pseudopod.
151. *Spaniotoma* (*Orthocladius*) *suspensa* sp. nov.; larva, claws of anterior pseudopod.
152. *Spaniotoma* (*Orthocladius*) *tentoriola* sp. nov.; larva, claws of anterior pseudopod.
153. *Spaniotoma* (*Orthocladius*) *saxosa* sp. nov.; larva, claws of anterior pseudopod.
154. *Cardiocladius capucinus* Zetterstedt; larva, claws of anterior pseudopod.
155. *Spaniotoma* (*Trichocladius*) *intermedia* sp. nov.; larva, claws of anterior pseudopod.
156. *Spaniotoma* (*Orthocladius*) *kibunensis* sp. nov.; larva, claws of anterior pseudopod.
157. *Spaniotoma* (*Orthocladius*) *kanii* sp. nov.; larva, claws of anterior pseudopod.
158. *Spaniotoma* (*Orthocladius*) *filamentosa* sp. nov.; larva, claws of anterior pseudopod.
159. *Chironomus* (*Chironomus*) *crassiforceps* Kieffer; larva, claws of anterior pseudopod.

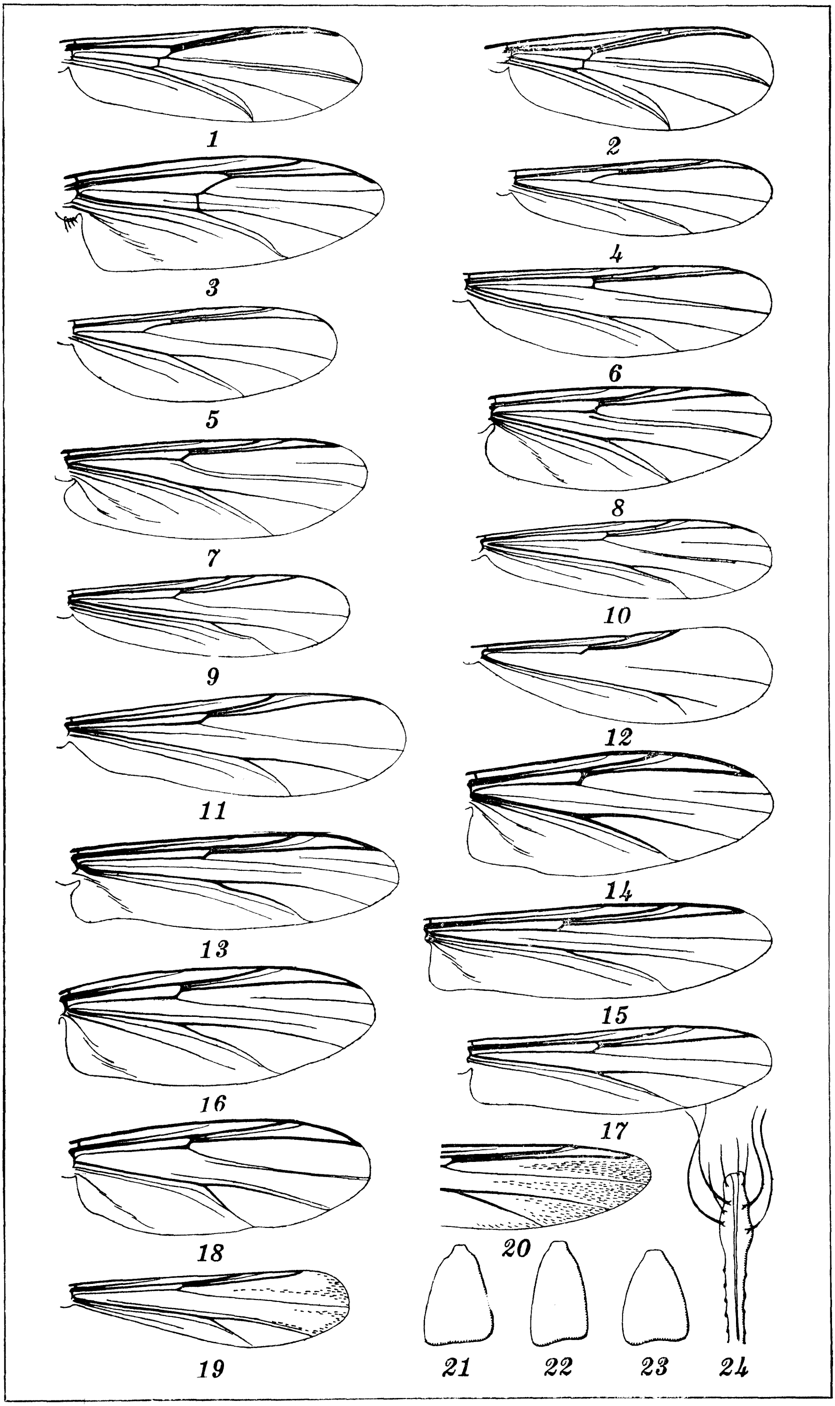

PLATE 1.

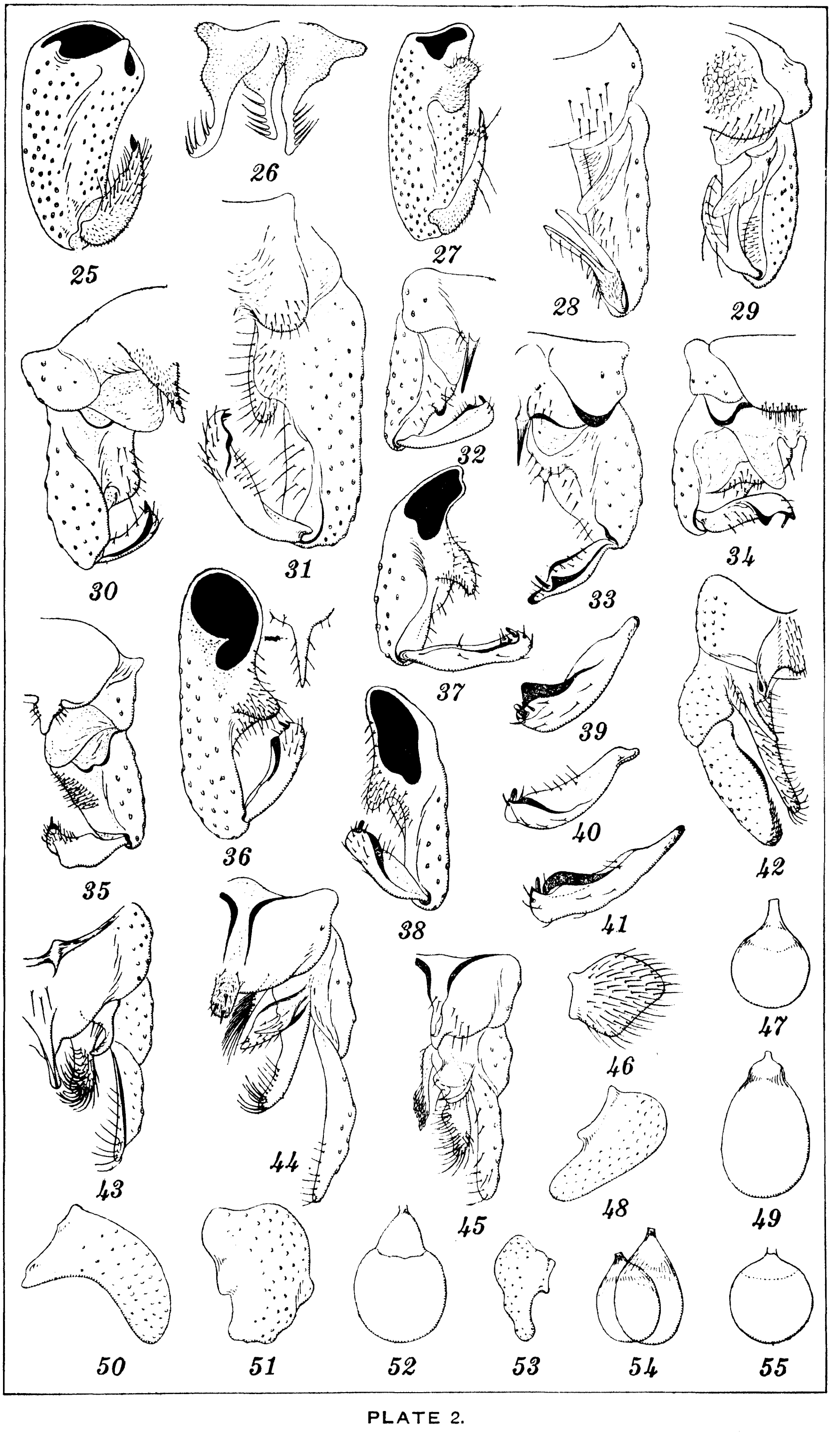
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PLATE 2.

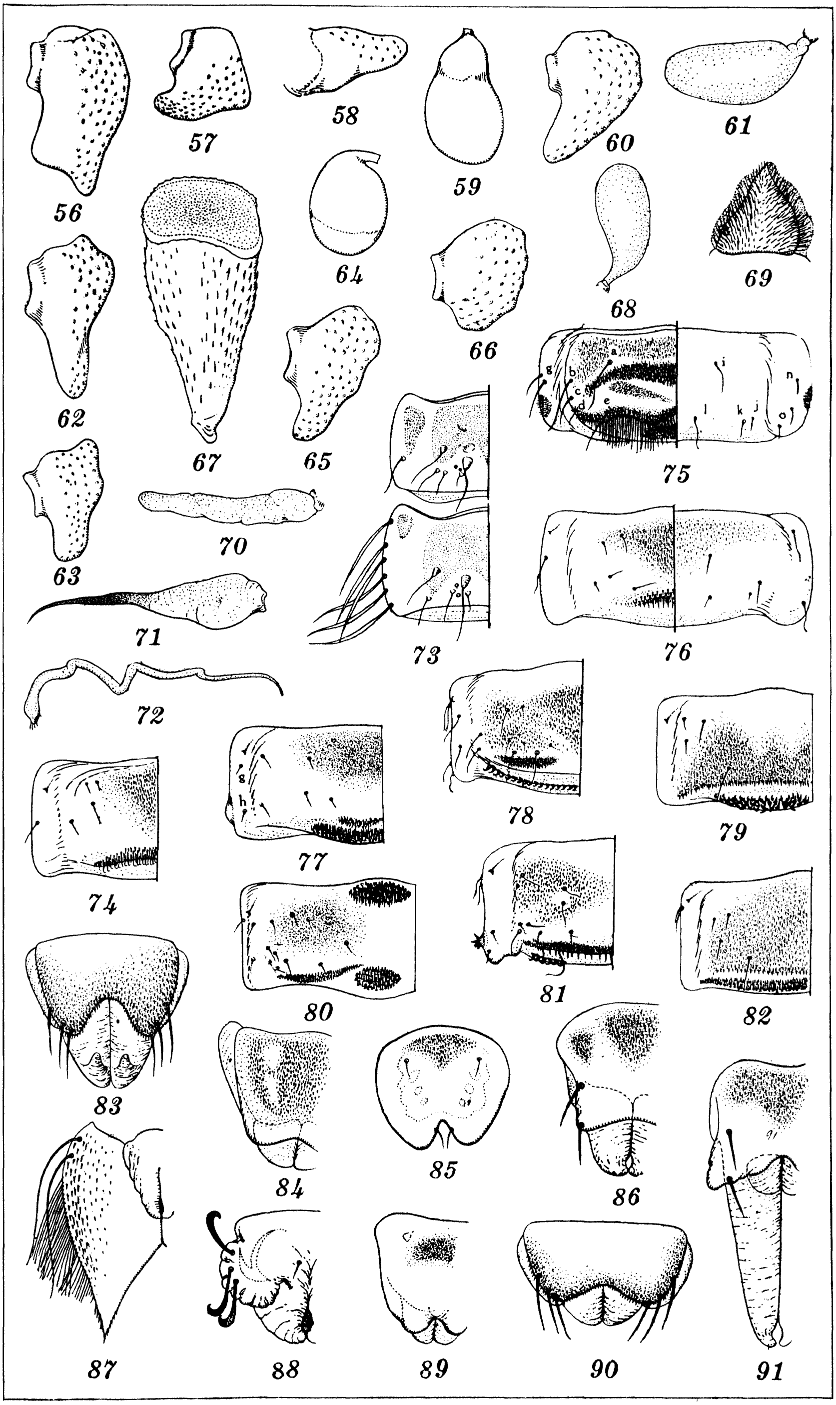
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PLATE 3.

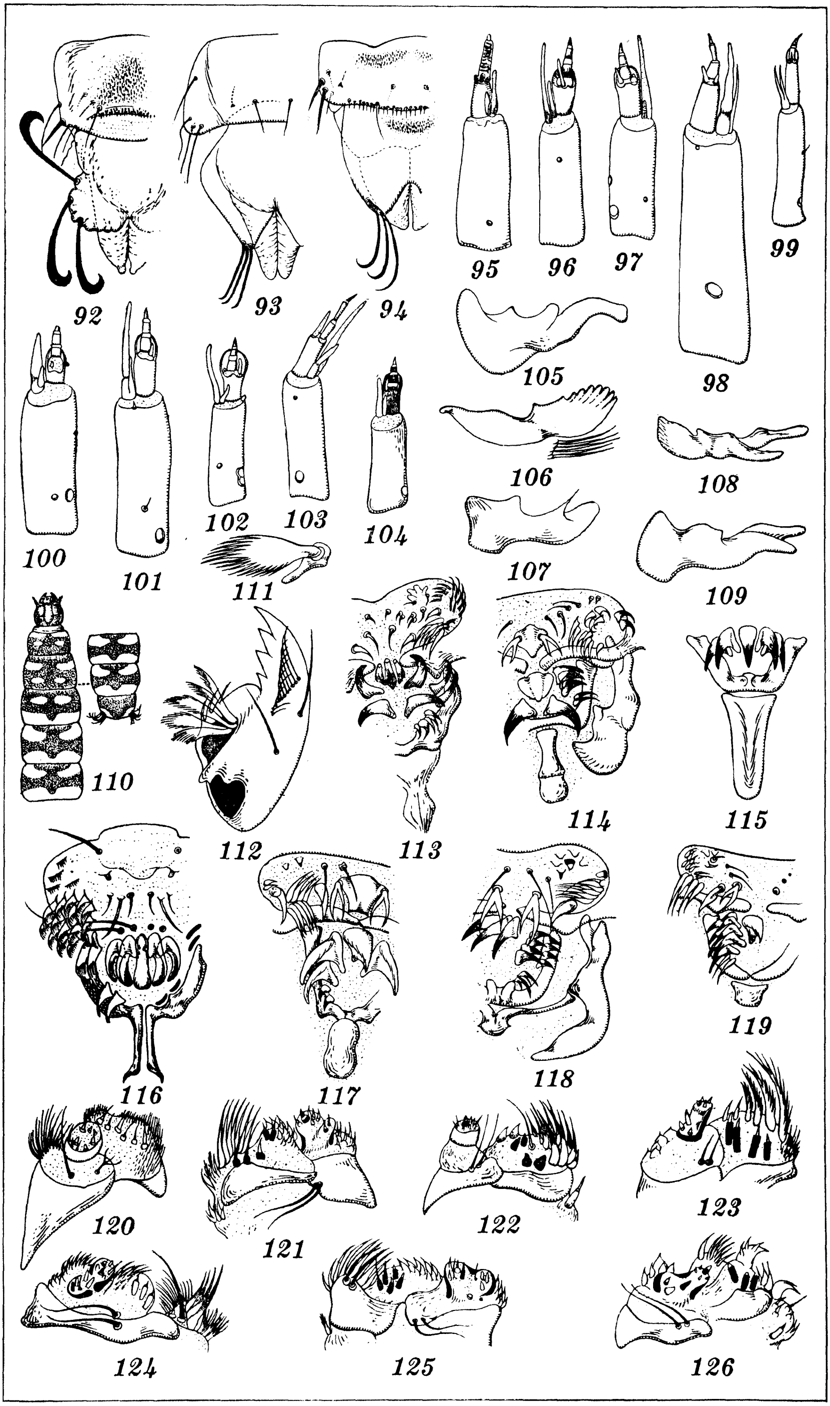
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PLATE 4.

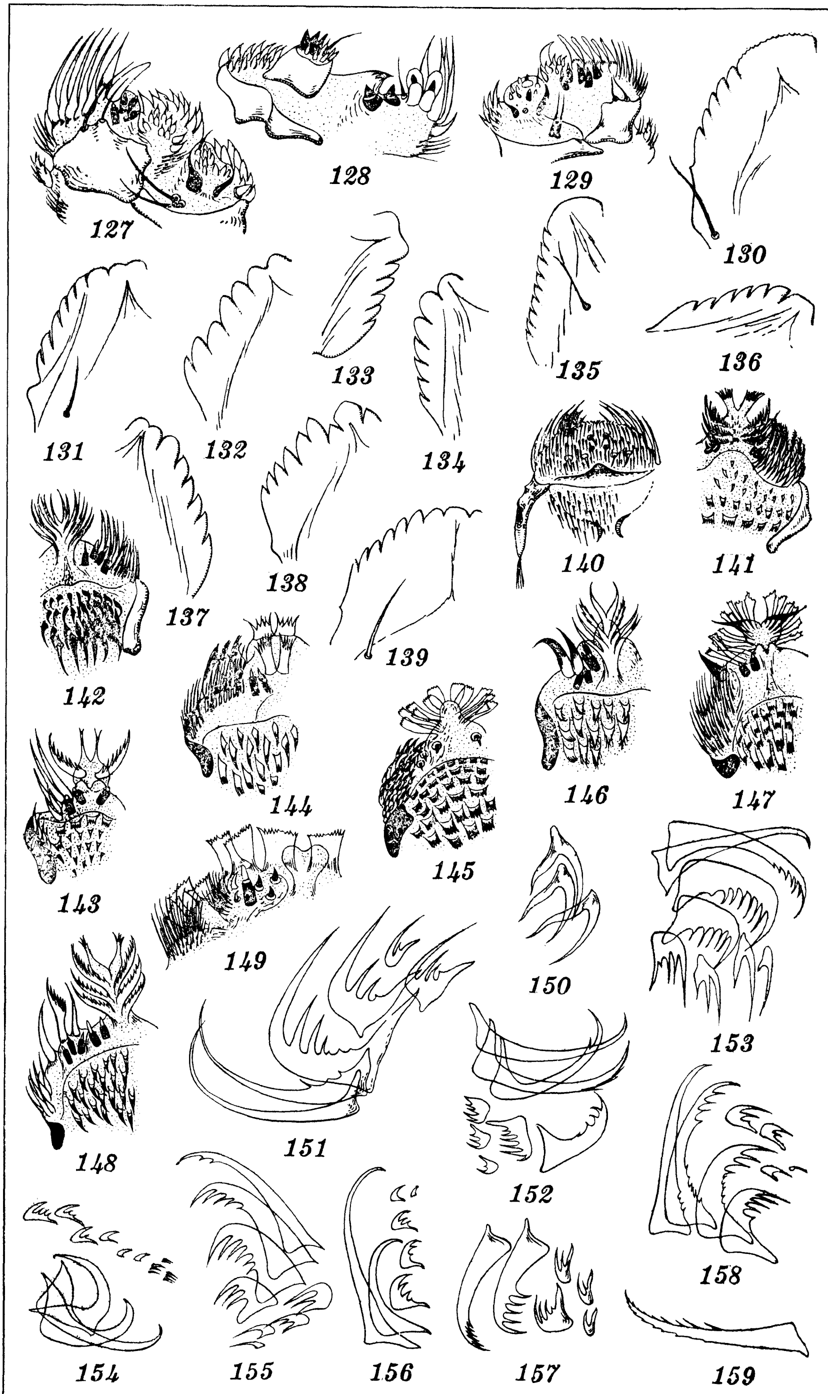
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PLATE 5.

STUDIES ON THE ANATOMY OF REMIPES TESTUDINARIUS LATREILLE, WITH SOME OBSERVATIONS ON ITS RELATIVE MORPHOLOGICAL AFFINITY

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FOUR PLATES

Only 4 species and 1 variety of the tribe Hippidea, distributed among 3 genera and 2 families, are known in the Philippines. They are as follows: Family Albuneidæ: *Albunea symnista* (Linnæus) and *Albunea microps* White; family Hippidæ: *Mastigochirus quadrilobatus* Miers, *Remipes testudinarius* Latreille, and *Remipes testudinarius* var. *denticulatifrons* (White). *Albunea symnista* and *Remipes testudinarius* and its variety are represented in the collection of the University of the Philippines. *A. microps* and *M. quadrilobatus* are mentioned only in foreign literature.(13)

The greater portion of this work on *R. testudinarius* was done at the Marine Biological Laboratory of the University of the Philippines at Puerto Galera, Mindoro, during a period embracing five summer sessions of about six weeks each.

The attempt to include the development of this animal did not have encouraging results, and this phase of the work had to be laid aside due to lack of opportunity, equipment, and appropriate methods of meeting the natural requirements of the developing embryos.

Embryos of different stages up to the zœa were obtained by catching the ovigerous females. Laboratory observations on stages later than the first zœa could not be made, because under captivity the females bearing embryos in this stage invariably shed them, and once separated from the mother the embryos live but a few hours. All efforts to make the zœa live longer and to bring about their development by artificially simulating their natural environment by constructing an artificial beach proved futile.

Claus(2) rejects the suborder Anomura and refers the Hippidea to the Brachyura, on the basis of what is known of their development. A more detailed knowledge of the develop-

ment of this animal will therefore throw some light on its relative position. It is the purpose of this work to study some of the peculiar morphological adaptive characteristics coincident to the animal's particular habitat, and to show, in a measure, to what extent internal organization, particularly that of the nervous system, supports the existing divergent views regarding the relative morphological affinity of the tribe Hippidea to which this species belongs.

ACKNOWLEDGMENT

I wish to take this opportunity to express my gratitude to Dr. Hilario A. Roxas, who, in spite of his manifold duties as head of the Fish and Game Administration, Bureau of Science, and as professorial lecturer in the University of the Philippines, found time to go over this paper. To the members of the staff of the Zoölogy Department of the College of Liberal Arts I wish to express my indebtedness for their constant encouragement and for coöperation rendered in various ways.

Order DECAPODA

Suborder ANOMURA

Tribe HIPPIDEA

Family HIPPIDÆ Stimpson, 1858

Genus REMIPES Stimpson

Remipes STIMPSON (1858, p. 229); LATREILLE (1806, p. 45); MILNE-EDWARDS, H. (1837, p. 204).

REMIPES TESTUDINARIUS Latreille.

Hippa adactyla FABRICIUS (1793, p. 474); LATREILLE (1803, p. 176).
Cancer emeritus HERBST (1796, p. 8, pl. 22, fig. 4).
Remipes testudinarius LATREILLE (1806, p. 45); LAMARCK (1818, p. 223); MILNE-EDWARDS, H. (1837, p. 406, pl. 21, figs. 14–20); HELLER (1865, p. 72); MIERS (1879, p. 316).
Remipes marmoratus WHITE (1847, p. 58); MIERS (1876, p. 59).
Remipes pacificus DANA (1852, p. 407, pl. 25, fig. 7); STIMPSON (1862, p. 241).
Remipes hirtipes DANA (1852, p. 408, pl. 25, fig. 8).
Remipes pictus HELLER (1861, p. 243).
Remipes ovalis MILNE-EDWARDS, H. (1863, p. 12, pl. 17, fig. 5).

Stebbing is of the opinion that the true name should be *R. adactylus*, the species having been named *Hippa adactyla* by Fabricius in 1793. The nomenclature as revised by Miers(13) is followed in this paper.

According to Miers this species is the one most widely distributed of the family. Specimens were collected from the Australian Seas, the Red Sea, from Mauritius, Zanzibar, Reunion, Nicobars, Soloo Island, Moluccas, Flores, the Philippines, Onsima, New Hebrides, Mallicollo, Fiji Islands, Ovalau, Samoa or Navigator's Islands, Sandwich Islands, Tahiti, from California, and from St. Lucas.

In the Philippines specimens were collected from Guimaras Island, Iloilo Province; Puerto Galera, Mindoro Province; Bauan, Batangas Province; La Union Province; Ilocos Sur Province; Ilocos Norte Province; and Aparri, Cagayan Province.

These crabs are popularly known as "mole shrimps," or "sand bugs," from their habit of burrowing under the sand. In Iloko they are called "ipis." They live gregariously along the water line in loose sandy beaches, preferring a mixture of fine gravel and coarse sand. In this respect they differ from the closely allied species, *Albunea symnista,* which prefers the finer and more compact sand. They follow the water line as it recedes during low water and as it advances at high tide. In sheltered places of bays and coves, where the makeup of the beach remains practically the same, these animals abound from year to year, as I observed for a period of about ten years in some places in Puerto Galera, Mindoro, in spite of the fact that sometimes the people collect them for food. On open seacoasts, like those of the Ilocos provinces, they shift with the shifting sand.

To catch them, the collector, with his back to the water, simply scoops up a handful of sand and shoves it farther up shore. He has to be quick and sharp-eyed, however, for the crabs run back quickly to the water, with their posterior end first, and dig into the sand and disappear within a few seconds. Sometimes they simply lie quietly as if dead, and as their color wonderfully harmonizes with that of the sand, they may easily escape the notice of the collector.

The color of these crabs varies with that of the sand where they live, the general background, however, usually being whitish to grayish, with arenaceous spots. They may be aptly described as "sand-colored."

EXTERNAL ANATOMY

Eyes.—The peduncles are slender, usually extending a little beyond the end of the basal joint of the antennules. There are three joints, the last one bearing the cornea. At the outer prox-

imal angle of the second joint is found a clump of fine plumed setæ.

Antennules.—The antennules are placed just below the eyes. The peduncle has three joints and bears two flagella. The primary or dorsal flagellum bears clumps each with from four to seven short and pointed chitinous tactile bristles (Plate 1, fig. 1, *tr b*), those on the ventral side being longer and not in cluster. The secondary or ventral flagellum bears around its joints long tactile bristles, those at the tip forming a clump (Plate 1, fig. 1, *f*). The bristles on the peduncles are of two kinds; those on the sides and upper surface are simple, while those on the under surface are plumed.

Antennæ.—The peduncle is 3-jointed. The primary flagellum has three segments and bears long simple tactile bristles. The secondary flagellum is rudimentary and invested with plumed bristles (Plate 1, fig. 2, f_2). In normal position the peduncle is inclined medially, and the flagella meet at the angle of the suboperculiform terminal joint of the third maxilliped which is held appressed over the buccal cavity.

The simple bristles on the antennules and antennæ apparently are sensory, while the plumed ones in conjunction with those found in the first and second maxillæ are perhaps accessory devices, acting as a sieve to prevent sediment from getting into the branchial chamber.

Mandibles.—The mandibles coordinate with and closely invest the walls of the oral opening. Their position is at the angle of the calcified triangular anterior portion and the noncalcified posterior portion of the wall of the mouth. The mandible appears rudimentary, apparently serving merely as an attachment of the palpus, which is attached at about the proximal third of the protognathite (Plate 1, fig. 3, *a*). The free margin of the outer portion of the palpus projects at an obtuse angle in front, facing the branchial channel. This margin is armed with about six or seven very short and stout obtuse spines at its anterolateral angle (Plate 1, fig. 3, *d*). The inner branch of the palpus (Plate 1, fig. 3, *c*), lying just above the labrum and closely appressed to it, is somewhat orbicular. Its terminal margin is armed with numerous long branching spinulose setæ, which evidently help in preventing sediment from getting into the buccal cavity.

First maxillæ.—The terminal portion of the inner lobe is a thick, heavily calcified rectilinear plate joined to the basal with a broad articulation (Plate 1, fig. 4, *a*). The terminal margin

of the first maxilla is armed on its outer edge with a series of six very large, short, stout, conical dentiform spines; at the angle at each end of the series are smaller spines. On the short posterior margin are several slender spinules. On the inner margin are numerous spinulous setæ which curve inward. The protognathal lobe bears plumose setæ. The exopodite is long, very narrow to near the expanded, spatulate extremity, the convex margin of which is densely armed with setæ which are stout and spiniform, except anteriorly where they are long and plumed. Similar plumed setæ invest the sides and the margin of its broad basal portion, on the lower margin of which are a few spinules.

Second maxillæ.—The second maxilla is composed of a protopodite, a median endopodite, and an outer exopodite known as scaphognathite. The protopodite is composed of a coxopodite and a basipodite. The coxopodite is composed of two lobes, one broadly rounded, the other, smaller and conical, situated between the former and the endopodite. The endopodite projects over the buccal opening, just anterior to the teeth-bearing terminal portion of the endopodite of the first maxilla which likewise hangs over the opening of the mouth. Its terminal margin is invested with stiff long setæ, which, together with those fringing the lateral margin of the endopodite of the first maxilliped and those of the first maxillæ, form a very efficient sieve to prevent the entrance of sediment into the buccal cavity. The exopodite (scaphognathite) is a thin membranous plate (Plate 1, fig. 5, *ex*) modified as a gill bailer that bails the water out of the prebranchial chamber. Its margin is heavily invested with featherlike hairs, the barbs of which form a very fine network which, while it helps to create the water currents, serves at the same time as an efficient strainer for fine sediments.

First maxilliped.—The exopodite of the first maxilliped (Plate 2, fig. 6) is composed of two joints, the terminal one falciform in outline with a concavity at the anterolateral angle. This fits into the bases of both the antennæ and antennule, and is rimmed with long and bushy stiff plumose setæ, which, together with those found at the bases of the antenna and the antennule, form an efficient means for preventing the entrance of sediment into the branchial chamber. The posterolateral margin fits into that of the inner anterolateral angle of the branchiostegite, while the long inner margin is held appressed to the side of the raised triangular anterior portion of the wall of the mouth. The endopodite (Plate 2, fig. 6, *d*) is a semielliptic calcified plate with

the side next to the buccal opening concave. It extends over the whole length of the buccal opening, and, together with that of the other pair, forms a sort of trap door closing the buccal aperture. The rim is thickly invested with plumed setæ, those of the inner posterior margin longer and more bushy. Along the inner margin are stout teeth fitting into the similarly arranged row of teeth of the other pair.

Second maxilliped.—The exopodite of the second maxilliped (Plate 2, fig. 7, *d*) is reduced into a 2-jointed filiform structure and densely invested with longish plumed setæ at its lateral margins. The endopodite is 4-jointed, the last joint broadly triangular and bearing a crown of stout spinulose bristles. Similar bristles invest the inner surface and outer margin of the preceding joint. These two joints are held appressed over the buccal opening. Dense plumose setæ line the lateral margins of the first two joints, and similar setæ crown the protognathal lobe (Plate 2, fig. 7, *b*).

Third maxilliped.—The third maxilliped is suboperculiform; its second joint is greatly enlarged, and the last is unguiform. In natural position the third maxillipeds are held over the buccal region, with the surface appressed to the mouth bearing strong bristles; elsewhere there are long plumose setæ (Plate 2, fig. 8). The exopodite is a 2-jointed delicate filamentous structure, rather rudimentary and bearing plumose setæ at the margins.

Legs.—The anterior legs are elongated, clothed with rather long hairs, which are densest on the inner margins and show a tendency to disposition in oblique series on the upper and outer margins of the last two joints. The last joint tapers somewhat to its extremity, which is clothed with long hairs. This leg is held parallel to the body and extends far beyond the anterior end of the body.

The second, third, and fourth pairs of legs are robust. The terminals of the second and third pairs are slightly falcate; the distal half short, broad, and obtusely rounded at the extremity. The distal half of the fourth pair is narrow and straight. The shape and structure of the second and third pairs of legs make them efficient tools for the animal in digging its way into the sand.

The last pair is more or less rudimentary in both sexes. In natural position it lies folded close to the fourth. Its last joint (Plate 3, fig. 11) is forked, the inner margin of the fork being

spoon-shaped. The hairs that invest the joints become more bushy around the forks. In the female this leg is evidently used in transferring the eggs and glueing them to the abdominal appendages which are provided with long setæ for the attachment of the eggs, and presumably in detaching the embryo at the time of hatching, as females bearing immature zœæ when placed in a pan of water were observed to shed the young by the rapid movements of the legs and the uropods.

Carapace.—The carapace is moderately convex and marked with numerous fine interrupted transverse lines. The postfrontal sinuses are distinct, the frontal lobes moderately prominent, obtuse, and rounded, and the lateral ones scarcely project beyond the median lobes. Series of shallow pits bordered with tufts of short hairs form a linear submarginal striated area on the lateral margins.

Abdomen.—The first segment of the abdomen is concave anteriorly, and fits closely to the carapace; two lines clothed with hairs traverse it, the anterior starting on either side of the somewhat prominent median dorsal elevation. The second segment is small, only about one-third the breadth of the first segment. The third and fourth, still smaller than the second, are hexagonal. The fifth and sixth are fused.

The telson is long, lanceolate, about seven-tenths the length of the carapace. The uropods are attached at the anterolateral angle. The two branches are flattened laterally and clothed with long hairs, the exopodite a bit longer than the endopodite (Plate 2, fig. 10, *u*). The tips of both are clothed with plumed setæ. In life the telson and abdomen are closely held under the body, the flexion being between the first and second abdominal segments, the telson reaching as far as the base of the first legs and over the buccal region.

Summary of the body somites and the corresponding appendages.—There are five pairs of appendages on the head and eight pairs on the thorax. There are four pairs of abdominal appendages in the female, excluding the uropods, and only one in the male. The appendages are as follows:

CEPHALON

Somite.	Appendages.
1	first antennæ (antennules)
2	second antennæ
3	mandibles
4	first maxillæ
5	second maxillæ

THORAX

Somite.	Appendages.
6	first maxillipeds
7	second maxillipeds
8	third maxillipeds
9	first pair of pereiopods
10	second pair of pereiopods
11	third pair of pereiopods
12	fourth pair of pereiopods
13	fifth pair of pereiopods

ABDOMEN

Somite.	Appendages (female).
14	first pleopods
15	second pleopods
16	third pleopods
17	fourth pleopods
18	fifth and sixth somites fused } no pleopods
19	last bears telson and uropods

INTERNAL ANATOMY

Digestive system.—The buccal cavity is imperfectly defined. The only prominent portion of the mouth is the raised triangular calcified portion that forms the anterior wall, the posterior wall being not well defined. The two horns produced by the extension of the posterior lateral angles of the calcified anterior wall clasp the soft labrum, whose sides extend posteriorly to form the lateral wall of the buccal opening. The posterior margin of the labium is entire and convex, while the anterior portion is divided into three lobes; the two lateral lobes meet the extension of the labrum. The pharynx is a short tube inclining almost vertically to the dorsal side to a short œsophagus which leads to the stomach, a roughly polygonal sac with a very thin membranous wall except in its posterior portion.

The stomach is divided into two distinct portions, the pyloric and the cardiac. Viewed from the dorsal surface, the cardiac portion appears like a broadly bilobed bag with the lobes extending laterally. The pyloric portion is short and narrow, hanging more or less vertically. The wall of the region near the pyloric region is thick and holds the three teeth of the gastric mill. The teeth are disposed in a manner similar to those found in the gastric mill of Macrura and Brachyura; one tooth is placed ventrally and the two other dorsolaterally. The pyloric opening leading to the intestine is practically in the same line with the opening to the œsophagus, at a short distance posteriorly. The small intestine extends from the pyloric portion of the stomach

to the anal opening which is situated at about the proximal third of the telson.

The digestive gland is known as the hepatic cæca, a very complicated lobed mass closely investing the stomach and extending the whole length of the intestine.

Feeding habits.—Prof. S. I. Smith (1874–1878) concluded: "the mouth parts of the adults are not adapted for ordinary prehension or mastication, but I am unable to make any positive statement in regard to the food of these animals. In all specimens examined the alimentary canal was filled with fine sand which seemed to be free from animal or vegetable matter. The material from the stomach, however, shows under the microscope a small quantity of vegetable matter, and it seems probable that the sand is swallowed for the nutritive matter it may contain."

The suggestion of Professor Smith that the animal swallows the sand for the organic matter it may contain cannot be supported by the character of the structure of the mouth organs and the alimentary canal. It is a physiological impossibility; for the crab, in order to get the necessary amount of food, would have to swallow a great deal of the coarse sand in which it lives buried. The alimentary canal, therefore, would have to be constructed for the passage of large amounts of debris, like in that of the earthworm or in holothurians, where the alimentary canal is more or less a straight tube and of about the same width throughout. In *R. testudinarius* the stomach is a big sac and the intestine a delicate and small tube. Moreover, if the animal simply extracts the organic matter from the sand it swallows, it has no need for the gastric mill, which is an organ for grinding and trituration; this organ then is not only useless, but is a hindrance to the passage of the large amount of debris that the animal has to swallow.

In the stomach contents of a number of individuals examined I found a large quantity of broken pieces of appendages of smaller crustaceans, presumably amphipods, isopods, some spicules of sponges, and some very small snails, as well as very fine sand grains. The animal may either be predaceous or a scavenger, possibly both. In this connection it should be recalled that the third maxillipeds are suboperculiform; the last segment is unguiform and provided with stout bristles on the inner surface of the last two joints; similar bristles crown the last joint of the second maxilliped and the inner surface of the preceding joint; a row of teeth lines the inner edge of the endopodite of

the first maxilliped—all these, in conjunction with the series of teeth and spinules of the first maxillæ, will be efficient organs for seizing and holding the prey. Besides those structures, there are the elaborate plumose setæ which have been mentioned before. These structures will hinder the process of swallowing, if the animal simply swallows sand for the organic matter it can extract. On the other hand, the obvious purpose of these plumose structures is to prevent the entrance of sand into the buccal cavity.

The few grains of sand found in the stomach were evidently taken with the food. As the sand is being continually stirred up by the waves, a few grains of sand are likely to enter into the mouth, especially during the process of ingestion, in spite of the presence of the elaborate plumose setæ in the mouth parts.

RESPIRATION

The prebranchial chamber is formed in the following manner: The anterior portion of the mouth is raised into a kind of a triangular wall with its apex more elevated and pointing anteriorly. In each side of this triangular wall is a broad concavity which increases the space between the buccal wall and the bases of the antennules and the antennæ. Over this space, as a sort of a roof, is the broad, flattened falciform terminal segment of the exopodite of the first maxilliped. The inner edge of this segment is appressed into the edge of the triangular buccal wall, while its posterolateral margin fits into that of the anterolateral margin of the branchial wall, and the concave anterolateral margin with its investment of bushy plumose setæ fits into the bases of the antennules and the antennæ, which have been described before as similarly clothed. These plumed structures strain the water currents that pass through the space between the antennules and through the space between these and the antennæ. The complicated movements of the exopodite of the second maxilla drives the water into the branchial chamber over the gills.

The branchial wall is articulated to the side of the carapace by a thin chitinous arthrodial membrane to allow the wall a certain amount of movement. The branchial wall is calcified as far as the base of the second pair of legs; from here posteriorly it is a muscular flap, an extension of the dorsal body wall with the margin free. The movement of this muscular flap in part, that of the branchial wall in general, and, to a certain extent, that of the gills, force the water out of the branchial chamber

through the canals between the rows of lamellæ that compose each gill through the spaces between the legs and alongside of the pleura of the carapace and the abdomen.

A continuous current of water is made to pass over the gills, entering at the opening between the bases of the antennules and through the space between the bases of the antennules and the antennæ, bailed out by the scaphognathite from the prebranchial chamber into the branchial chamber, and from here driven out as described.

There are nine pairs of gills, all of the phyllobranchiate type. They are elongated and tapering toward both ends, and are placed oblique to the longitudinal axis of the body. Each gill is composed of a double row of broadly ovate laminated plates attached to a horizontal attachment which in turn is attached at about its middle point by a short membranous fold of the arthrodial membrane of the coxopodite of the gill-bearing appendages. This arrangement allows the gills a certain amount of freedom of movement anteroposteriorly. The first five gills are bent just above their middle point, each making an obtuse angle that faces posteriorly. This adaptation serves two purposes: To allow more space at the opening of the branchial chamber, and at the same time to make the current of water move posteriorly.

The branchiæ are placed as follows: The first pair of gills are attached by a membranous extension (arthrodial membrane) at the base of the coxopodite of the third maxilliped. The others are similarly attached by the arthrodial membrane fold—the second and third pairs to the base of the coxopodite of the first pereiopod; the fourth and fifth pairs, the sixth and seventh, and the eighth and ninth pairs to the bases of the second, third, and fourth pereiopods, respectively. All gills are podobranchs, since they are all attached to the bases of the appendages. Plate 3, fig. 13, shows one of the gills.

REPRODUCTIVE SYSTEM

The male gonad (Plate 3, fig. 11) is composed of a testis consisting of five lobes and a short and threadlike vas deferens which enlarges posteriorly to form a bigger tube, the seminal vesicle. The seminal vesicle narrows posteriorly to form a short ejaculatory duct which opens to the genital papilla at the base of the last thoracic leg. This leg, as previously described, has chelate fingers which are spoon-shaped and clothed with a thick brush. The spoon-shaped fingers probably serve to transfer the

sperm. The gonad can be easily removed by removing the legs, cutting through the sternum, and pulling the last thoracic leg.

The female gonad is located at the side of the stomach running along side of the intestine. The oviduct opens at the space between the first and the second abdominal appendages. In nonovigerous females it is quite difficult to discern the ovary, but in ovigerous females it practically fills the cephalothoracic cavity. The eggs are at first irregular, becoming more rounded as soon as they are extruded, and measure about a millimeter in diameter.

The nature of the development of this animal presents an interesting field for investigation. The writer in his attempts was able to observe only as far as the first zœa stage, partly due to the fact that the ovigerous female under laboratory conditions invariably sheds the embryo, which then cannot be induced to proceed with its development, even under artificially simulated conditions of the beach. Plate 4, figs. 16 to 19, shows some of the stages in development.

CIRCULATORY SYSTEM

The circulation of the blood can be partly seen quite plainly in the zœa through the transparent carapace. The heart is pentagonal, and lies within the pericardium on the dorsal side of the cephalothorax, giving off three arteries from the anterior end, the artery in the median line running to the base of the rostrum. This is the ophthalmic artery in the adult, and supplies blood to the head region. The two other arteries arise from the anterolateral sides and can be seen dipping into the base of the second pair of appendages. From the posterior part of the heart two arteries arise at about the same point in the middle line of the body, one dorsal, extending posteriorly through the abdomen on the dorsal side, and the other ventral, passing ventrally. These two blood vessels correspond to the abdominal and sternal artery, respectively, in the adult. The blood from the cephalothorax may be seen coursing back to the heart, along the border of the carapace. As no trace of gills exists in this stage, the blood must be aërated through the thin walls of the carapace.

In the adult the heart, viewed from the dorsal side, is roughly hexagonal. At its anterior end is the median cephalic artery (ophthalmic artery), on each side of which, arising from about the same trunk, is the lateral artery; at each anterior angle is

a hepatic artery. All these arteries pass forward. At the posterior end, arising at about the same point, are two median arteries: the sternal artery, which dips ventrad, and the posterior aorta, which passes caudad and above the intestine. At the origin of each artery there is a valve which prevents the blood from returning.

The cephalic artery (Plate 3, fig. 12, *o*) pursues a straight course over the pyloric and gastric portion of the stomach, then dips ventrad and splits into two main branches which supply the eyes, and to other parts of the frontal region. The lateral arteries (antennary) arise from the same trunk as the cephalic artery, then pass outward making an acute angle with the latter. The hepatic artery is a pair arising from the ventral side of the anterior angle of the heart. On leaving the heart, each dips ventrally and becomes embedded in the digestive gland. Near its origin it gives off a branch which supplies the hind gut. There are other small branches which supply various parts of the digestive gland.

The posterior aorta (superior abdominal artery) arises from the median posterior end of the heart, and just under this vessel is the descending artery.

This system requires further study in detail.

NERVOUS SYSTEM

The central nervous system (Plate 3, fig. 14; Plate 4, fig. 15) follows the same plan as that found in Macrura, consisting of: (*a*) a brain connected by commissures to (*b*) the subœsophageal ganglion, (*c*) a chain of thoracic ganglia, and (*d*) a chain of abdominal ganglia. It differs, however, from some macrurous types of nervous system in two principal aspects; first, instead of the usual five, distinct and equally prominent separate thoracic ganglia, as in *Penæus,* the first two thoracic ganglia are fused with the subœsophageal ganglion. Secondly, in the abdomen there are only five ganglia which are reduced in size. There are six of these in *Penæus,* and they are about as prominent as those of the thoracic ganglia.

The brain is formed of a complex mass of nerve cells and fibres. The nerve fibres become aggregated in the brain in definite masses or neuropiles ("Punksubstanz," Leydig). The principal neuropiles are: (*a*) the optic, *op;* (*d*) the superolateral, *dl;* (*c*) the superomedian, *dm;* (*d*) the globulus, *g;* and (*e*) the posterior neuropiles, *pm.*

The optic neuropiles each consisting of two lobes are situated at the anterior end of the brain, the posterior lobe bearing the optic nerve fibres and the oculomotor. The superolateral is a pair, each giving rise to the otocyst nerve fibres. Between this pair is the superomedian neuropile. From the ventral surface of this neuropile arises a nerve fibre which terminates in a swollen mass, which may possibly be regarded as a ganglion, lodged in the space beneath the median frontal lobe between the bases of the antennules. No mention is made in the literature available regarding a similar structure. Investigation concerning the nature, function, and, perhaps, phylogenetic homology may reveal some interesting facts. The aforementioned neuropiles compose the anterior half of the brain.

On each side of the posterior half is a very prominent globular mass, the globulus, to which are connected partly some of the fibres of the antennulary and the antennary. The tegumentary nerve fibre is attached to this mass. The posterior neuropile is continuous with the commissures. The visceral nerve fibres (v_1, v_2) arise from this neuropile.

The relations of the nerve masses and nerve fibres can be seen quite plainly on the ventral side of the brain (Plate 3, fig. 14). The following nerve fibres are connected with the brain:

Optic nerve (*o n*).—Each optic nerve arises from the dorsal side of the brain at its anterior angle. The fibres are continuous with those of the optic neuropiles. The nerve enlarges to form the optic ganglion in the eye peduncle. From this ganglion arise the nerve fibres that innervate the ommatidia of the eye.

Oculomotor nerve (*om n*).—The small nerve fibers that innervate the muscles connected to the eye peduncles arise from the ventral side of the optic neuropiles.

Antennulary nerve (at_1).—On the antennulary nerves some of the fibres originate from the ventral side of the optic neuropile and some from the globular mass. The antennulary nerve appears to be single, but is composed of two different kinds of fibres having different functions and arising from different centers in the brain. The main branch, innervating the antennules, arises from the ventral side of the brain. The branch that innervates the tactile organs seems to arise at the lateral side of the optic neuropile.

Antennary (at_2).—The antennaries are smaller than the antennularies, and innervate the antennæ. The fibres of these nerves seem to be derived from both the anterior and posterior half of the brain.

Tegumentary nerves (*tn*).—The tegumentary nerves are a pair of fairly big nerves arising from the globulus and passing outwards almost at right angles to the longitudinal axis of the body. They innervate the integument at the side of the body.

Visceral nerves (v_1, v_2).—There are two pairs of visceral nerves, and they may be regarded as the anterior and posterior nerve fibres. Both are connected to the posterior neuropiles. The anterior pair passes outwards to the anterior portion of the hepatic region, while the posterior pair passes over the gastric region.

Otocyst nerves (*ot n*).—The otocyst nerves on the dorsal side of the brain arise from the superolateral neuropiles. At a certain distance from the point of origin from the brain the two nerves are connected by a transverse nerve fibre. Above the transverse nerve a small nerve fibre branches out to supply the muscle that runs along the middorsal region of the body. The otocyst nerve terminates in a swollen mass, the otocyst ganglion, from which several fine nerve fibres branch out that possibly innervate the setæ in the otocyst sac. The function of this sac in some members of the crustacean group is still a matter of doubt. Some claim that it merely helps in maintaining equilibrium, while others hold that it is auditory in function.

Commissures (*co*).—The commissures are a pair of large nerve fibres, continuous with the posterior neuropiles, and passing posteriorly on each side of the œsophagus to the subœsophageal ganglion.

Subœsophageal ganglion (*s, g*).—The subœsophageal ganglion is situated just behind the œsophagus. It is formed by the fusion of the swollen terminals of the commissures. In its center may be seen the arterial foramen. Some of the nerve fibres connected to this ganglion are the stomatogastric nerves (*st n*) and some of the nerves that innervate the mouth appendages.

Thoracic ganglia ($th\ g_1$–$the\ g_5$).—At first glance only four ganglia are distinctly discernible, due to the fusion of the first and second thoracic ganglia with the subœsophageal ganglion, but by closer examination under the microscope the demarcation between these three ganglionic masses can be seen distinctly. A number of nerves arise from each ganglion innervating the corresponding region of the body and the corresponding appendages. The largest nerves are those that innervate the thoracic legs, except the one that goes to the fifth leg. This nerve is small and arises just behind the nerve that innervates the fourth leg.

The subœsophageal ganglion in Macrura is generally formed by the concrescence of the ganglia of the last three cephalic and the first three thoracic segments. In *Remipes* further fusion takes place, indicating distinctly a progressive evolutionary step toward further centralization from the macrural to the brachyural type.

Abdominal ganglia ($ab\ g_1$–$ab\ g_5$).—The tendency toward further centralization is supported by the reduction in number and in size of the abdominal ganglia. In typical Macrura there are six of these ganglia, about as prominent as the thoracic ganglia. In *Remipes* there are only five, and they are very much reduced in size, except the fifth which supplies the telson and the uropods.

SYSTEMATIC POSITION

Authors differ as to the classification and the relative affinities of the Hippidea. I shall only mention the views of four authors, because of their being more or less directly opposed to each other. Benedict(1) considers the Hippidæ and Albuneidæ to make up the superfamily Hippoidea of the Macrura anomalia.

Claus(2) rejects the suborder Anomura and refers the Hippidea to Brachyura on account of what is known of their development.

Dana,(3) tracing the relations of the different groups of Anomura to the higher types of Brachyura, concluded that they may with equal propriety be classified (*a*) "as in a linear descending series they deviate from the brachyural to the macrural type, or (*b*) according to their respective natural affinities with the higher brachyural subtribes."

In the former system the Hippidea are ranked by him with the Porcellanidea, as constituting the second section, *Anomura media*, of the tribe Anomura; in the latter they are classed as *Anomura corystidica*, immediately beneath the Corystidea, which are undoubtedly cancroid Crustacea.(13)

Miers,(13) commenting on Dana's view, remarks:

With all deference to the opinion of the distinguished American naturalist, I must regard the older view as the more correct. I believe their true affinities are with the Oxystomatous Brachyura, through the Raninidea. They resemble this latter in their narrow and elongated form, natatorial legs, and in the case of the Albuneidæ in the high and laterally compressed hands of the anterior legs, which altogether resemble those of the Oxystomatous Calappa and allied genera. On account of the imperfect definition of the buccal cavity, it is easy to trace any resemblance either to the Cancroidea or to Oxystomata in the form of the mouth and oral ap-

pendages. There exists, however, an important characteristic and one, I believe, not hitherto noted, in the form of the terminal lobe of the exognath of the first pair of maxillipeds, which in the Hippidea, is elongated and narrow as in the Oxystomata, where it is usually applied to the opening of the afferent branchial channel. In the Cancroidea and Oxystomata, this joint is more or less obtriangular, short, and truncated at the distal extremity.

The conclusion of Miers is based on similarities in the form of the body, legs, and mouth appendages. Though these are significant and have their relative value, they are not sufficient to establish actual relationship between one animal and another, much less between one group and another, for they may be mere adaptive modifications, the results of the interplay between similar environmental conditions on one side, and on the other, between widely different animals—producing a resemblance not based on actual genetical relationship, but constituting a convergence. Supporting this line of argument is the fact that the members of the Oxystomata—the families Raninidæ, Leucosidæ, and Calappidæ, are generally sand diggers, like the members of the Hippidea. Living practically under identical ecological conditions, they face similar situations; namely, having to make their way into the sand and having to prevent sediment from clogging the buccal cavity and the branchial channel. Hence they have undergone adaptive modifications in the same direction.

Instances where animals had been placed wrongly because of some external resemblance to a group are too numerous to mention here. External evidence must be borne out by evidence in the internal organizations of the animal, and the more reliable criterion for determining the relative affinity between animals is the organization of the nervous system.

Jones(8) says,

There can be no doubt that the nervous matter must be regarded as the very essence or being of all creatures, with which their sensations, volition and capability of action are inseparably connected; and such being the case, it is a legitimate inference that the capacities and powers of the several tribes are in immediate relation with the development and perfection of this supreme part of their organization, and their entire structure must be in accordance with that of the nervous apparatus which they possess.

From what is shown in the degree of centralization, it is obvious that the organization of the central nervous system of *Remipes* is only slightly in advance over that of a prawn, a macruran, which consists in the coalescence of the first and second

thoracic ganglia with the subœsophageal ganglion, and in the reduction in size and number of the abdominal ganglia.

As a basis for comparison, let us take the organization of the nervous system of the spiny lobster, *Panulirus versicolor* (Latreille) (Plate 4, fig. 22). In this animal the subœsophageal ganglion had fused with the first three thoracic ganglia, hence the fusion has gone a little further than what has taken place in *Remipes*. *Panulirus* is distinctly macrurous in character, and I am not aware of any systematist who claims otherwise. However, while centralization in the thoracic ganglia has gone further in *Panulirus,* this process lagged behind relative to the abdominal ganglia, of which there are still six, whereas there are five in *Remipes,* in which this character may be viewed as a corresponding adaptive response to its particular habitat. To successfully bore its way through the sand, an animal must not only have its abdomen flexed but also be reduced in size.

An illustration of further concressence beyond that observed in *Remipes* and *Panulirus* is the nervous system of the coconut crab, *Birgus latro* (Linn.), an anomuran. In this animal all the thoracic ganglia have fused to form one mass, and the abdominal ganglia, though still distinct, have undergone further reduction in size (Plate 4, fig. 20).

The process of centralization, insofar as it has taken place in Crustacea, reaches its climax in Brachyura. Plate 4, fig. 21(16) shows the nervous system of a representative of this group. All the thoracic and abdominal ganglia become agglomerated into one mass, the ventral nerve mass from which nerves radiate to the thoracic and abdominal appendages.

If *Remipes* is placed under Anomura, it certainly should occupy a position on the lower rung of the scale, below that of Paguridea. Benedict's creation of the superfamily Hippoidea of the Macrura anomalia appears to have more justification than Dana's Anomura media, with a position close to Brachyura. By virtue of the possession of a higher degree of nervous centralization, the tribe Paguridea as represented by the coconut crab is more entitled to this position.

On the basis of progressive cephalization as indicated in the nervous organization it seems to me the more legitimate position for Hippidea as represented by *Remipes testudinarius* is with the Macrura; they may be regarded as an aberrant group of the division Phyllobranchiata. They agree with this division in having the branchial plumes in the form of broad foliaceous

plates attached to a central stalk. The degree of centralization shows an advance over that of a prawn, but less than the advance of *Panulirus*, another macruran.

However, the members of the two families Hippidæ and Albuneidæ, of the tribe Hippidea, resemble the anomurans in many respects, principally in the reduction in the size of the abdomen and in the manner in which this part is held under the body. On the other hand, their large and prominent telson and uropods, and their separate and distinct abdominal pleura except the fifth and sixth which are fused (in *Remipes*), point to their macrural affinity.

They also resemble the brachyurans in several aspects: (*a*) in the relative flattening of the body dorsoventrally; (*b*) in the greater prominence of the cephalothorax; (*c*) in the character of the legs, and (*d*) in the character of the mouth appendages. It is on the basis of these last two that Miers associates them with the oxystomatous brachyurans through the Raninidea.

While these facts are significant and undoubtedly have their merit in the consideration of affinities among animals, we should not lose sight of the deeper internal structural organization, ideally that of the nervous system, which is generally considered the more reliable index of the degree of organization in animals, and consequently, of their relative affinities. Indeed, as a general rule, it is customary to arrange animals in an ascending scale according to the degree to which the nervous system is developed.

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ILLUSTRATIONS

FIG. 1. Antennule (first antennæ), ventrolateral view; × 6. *a*, Basal segment of peduncle; *b*, second segment of peduncle; *c*, distal segment of peduncle; *d*, basal segment of secondary (ventral) flagellum; *e*, basal segment of primary (dorsal) flagellum; *f*, secondary flagellum; *g*, primary flagellum; *tr b*, tactile bristles.

2. Antenna, ventrolateral aspect; × 6. *a*, Basal segment of peduncle; *b*, second segment of peduncle; *c*, distal segment of peduncle; f_1, primary flagellum (dorsal); f_2, secondary flagellum (ventral).

3. Mandible, dorsolateral view; × 10. *a*, Basal portion; *b*, outer portion of palpus; *c*, inner branch of palpus; *d*, lateral spinous margin of basal portion of palpus.

4. First maxilla (enlarged), ventral view. *a*, Protognathal portion of endopodite; *b*, protognathal lobe; *c*, exopodite; *d*, muscle.

5. Second maxilla, inside view; × 2. *ex*, Scaphognath, gill bailer; *en*, endognath; *b*, basipodite.

PLATE 2

FIG. 6. First maxilliped, left side, inner surface; enlarged. *a*, Basal attachment; *b*, proximal segment of exopodite; *c*, terminal segment of exopodite; *d*, endopodite.

7. Second maxilliped left side, inner surface, enlarged. *a*, Basal attachment; *b*, protognathal lobe; *c*, first segment of endopodite; *d*, first segment of exopodite (flabellum).

8. Third maxilliped, left side, inner surface; enlarged. *a*, Basal attachment (basi-ischiopodite); *ex*, exopodite.

9. Dorsal view, abdomen and telson stretched out. a_1, Antennule, first antenna; a_2, antenna; per_1, first pereiopod; per_2, second pereiopod; per_3, third pereiopod; per_4, fourth pereiopod; max_3, third maxilliped; *t*, telson; *u*, uropod.

10. Abdomen, telson stretched out, ventral view, × 0.9. per_5, Fifth pereiopod; ap_1, first abdominal pleuron; *a ap*, anal aperture; *u*, uropod; *t*, telson.

PLATE 3

FIG. 11. Reproductive system of male; × 2. *te*, Testis; *vd*, vas deferens; *s v*, seminal vesicle; *g p*, genital papilla; *f*, spooned finger of fifth pereiopod.

12. Heart and vessels; enlarged. *e*, Artery to eye; *o*, ophthalmic artery (cephalic); *at*, lateral artery (antennary); *g*, gastric artery; *h*, hephatic artery; *p g*, posterior gastric; *ab*, abdominal artery; *st*, sternal artery; *bc v*, branchiocardiac vein; *ib s*, infrabranchial sinus.

FIG. 13. Gill; enlarged. *st*, Arthrodial membrane fold attaching gill to base of gill-bearing appendage; *c*, horizontal stalk; *fp*, one of the foliaceous plates.

14. Brain, subœsophageal ganglion, one of thoracic ganglia, ventral view, enlarged. *p g*, ganglion; *ot g*, otocyst ganglion; *ot n*, otocyst nerve; *om n*, oculomotor nerve; *on*, optic nerve; at_1 antennulary nerve; at_2, antennary nerve; v_1, v_2, visceral nerves; *co*, commissures; *st n*, stomogastric nerves; *s g*, subœsophageal ganglion; *af*, arterial foramen; mx_3, nerve to third maxilliped; th_1, first thoracic ganglion; pn_1, nerve to the first pereiopod.

PLATE 4

FIG. 15. Central nervous system, with anterior portion to second thoracic ganglion more enlarged than posterior; dorsal view. at_1, antennulary nerve; at_2, antennary nerve; *t n*, tegumentary nerve; v_1, v_2, visceral nerves; *g*, globulus; *p m*, posterior neuropyle; *p g*, ganglion; *ot g*, otocyst ganglion; *ot n*, otocyst nerve; *dl*, dorsolateral neuropile; *op*, optic neuropile; *dm*, superomedian neuropile; *om n*, oculomotor nerve; *o n*, optic nerve; *co*, commissure; *st n*, stomogastric nerves; *s g*, subœsophageal ganglion; *af*, arterial foramen; $th\ g_1$–$th\ g_3$, thoracic ganglia; pn_1–pn_5, nerves to pereiopods (walking legs); mx_3, nerve to the third maxilliped; $ab\ g_1$–$ab\ g_5$, abdominal ganglia; *u n*, nerve to uropods; *cd*, caudal nerve.

16. *a*, Egg undergoing cleavage (enlarged); *b*, section.

17. Older embryo still attached to pleopod of mother (enlarged). *a*, Stalk, a drawn-out portion of chorionic membrane of embryo; *b*, eye spots.

18. Nauplius; enlarged. *a*, Rostrum; *b*, eye, developing; *c*, abdomen.

19. First zœa, shed by the mother a few hours after capture. *a*, Rostrum; *b*, eye; *c*, mouth appendage; *d*, abdomen; *e*, telson.

20. Nervous system of coconut crab, *Birgus latro* (Linn.). After F. Nemenzo. *o*, Optic nerve; *al*, anterior lobe of brain; *a*, antennulary nerve; *at*, antennary; *p l*, posterior lobe of brain; *cc*, circumœsophageal connective; *p c*, postœsophageal commissure; *s*, ganglionic mass in circumœsophageal connective; *s n*, sympathetic nerve; max_1, nerve to the first maxilla; max_2, nerve to second maxilla; mlp_1, nerve to first maxilliped; mlp_2, nerve to second maxilliped; mlp_3, nerve to third maxilliped; p_1 nerve to first pereiopod; p_2, nerve to second pereiopod; p_3, nerve to third pereiopod; p_4, nerve to fourth pereiopod; p_5, nerve to fifth pereiopod; *th g*, thoracic ganglionic mass; *st*, arterial foramen; abd_1, first abdominal ganglion; *abd c*, abdominal nerve cord.

21. Nervous system of a crab, *Cancer pagurus*. After Joseph Pearson, 1908. *c g*, Cerebral ganglion; *a n*, nerve to first antenna; $a_2\ n$, nerve to second antenna; *o n*, optic nerve; *o m n*, ocular motor nerve; *t n*, tegumentary nerve; *p g*, parœsophageal ganglion; *n m*, nerve to mandibular muscle; *n p o*, transverse postœsophageal connective; *œ*, œsophagus; *com*, commissure; *t g*, ventral thoracic nerve mass; *n f*, foramen of ventral

nerve mass for descending artery; *n ab*, abdominal nerve; *st s*, superior root of stomatogastric nerve; *st i*, inferior root of stomatogastric nerve; *st n*, stomatogastric nerve; *st g*, stomatogastric ganglion; *l g n*, lateral gastric nerve; *p g n*, posterior gastric nerve; *nt*, nerve to integument; *n i*, nerve to hind gut; *n l*, nerve to digestive gland; n_1–n_9, nerve arising from ventral nerve mass.

22. Nervous system of *Panulirus versicolor* (Latr.); ventral view. After D. K. Villaluz, in MS. *o*, Optic nerve; *a*, antennulary nerve; *a t*, antennary nerve; *s o g*, supraœsophageal ganglion or brain; *c c*, circumœsophageal connectives; *œ*, œsophagus; *m*, mandibular nerve; mx_1–mx_2, first and second maxillary nerves; p_1–p_5, first to fifth pedal nerves; *sub o g*, subœsophageal ganglia; *st*, perforation for passage of sternal artery; 1–6, abdominal ganglia; *ab c*, abdominal nerve cord.

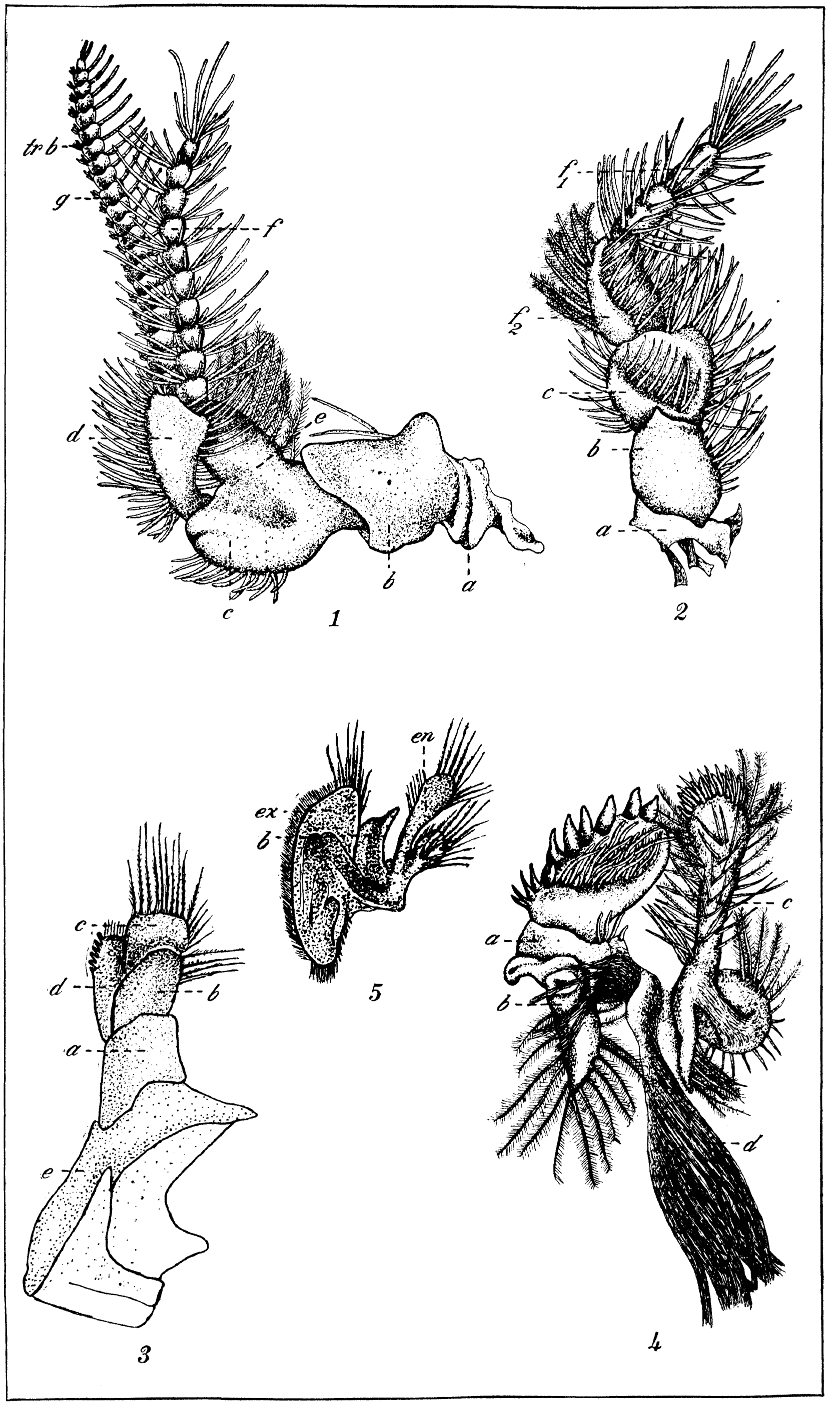

PLATE 1. REMIPES TESTUDINARIUS LATREILLE.

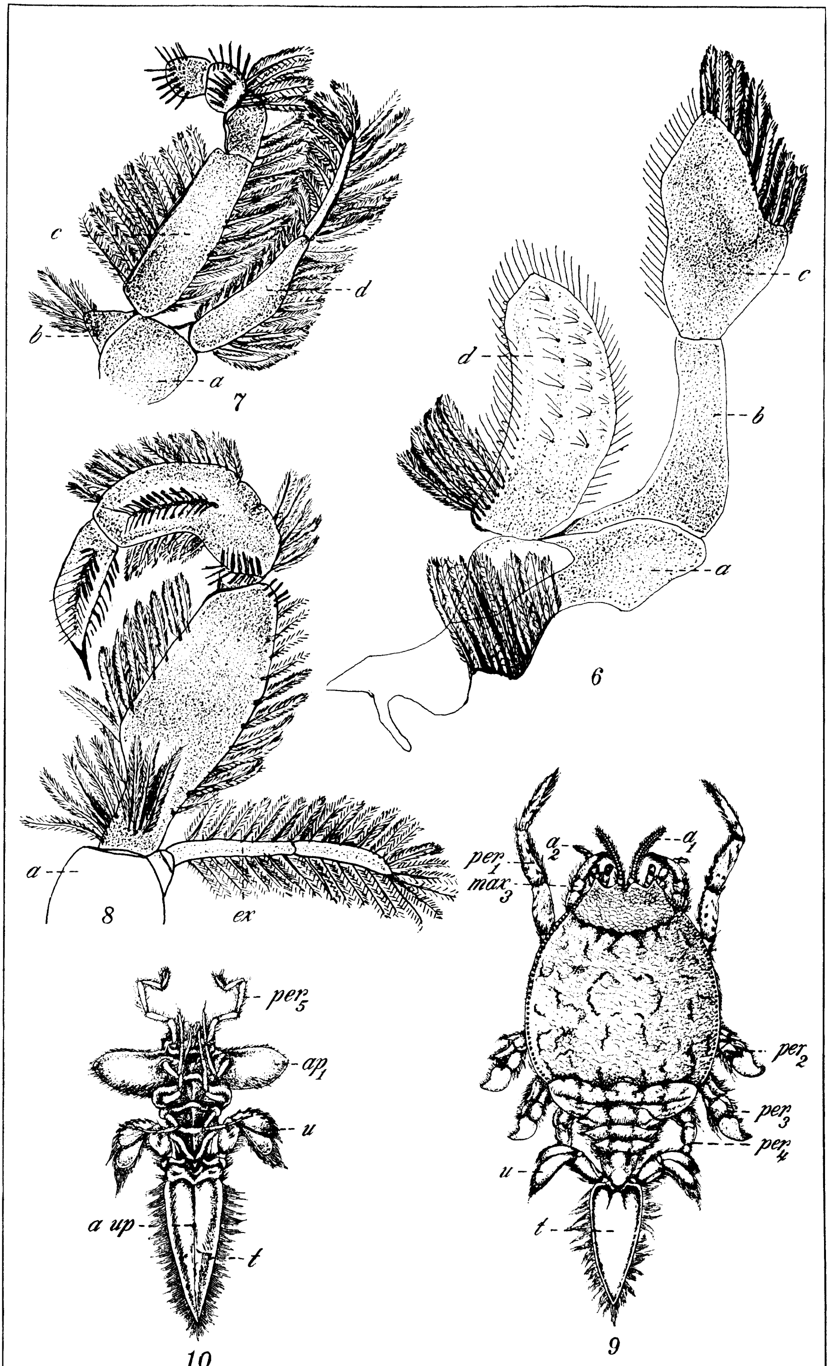

PLATE 2. REMIPES TESTUDINARIUS LATREILLE.

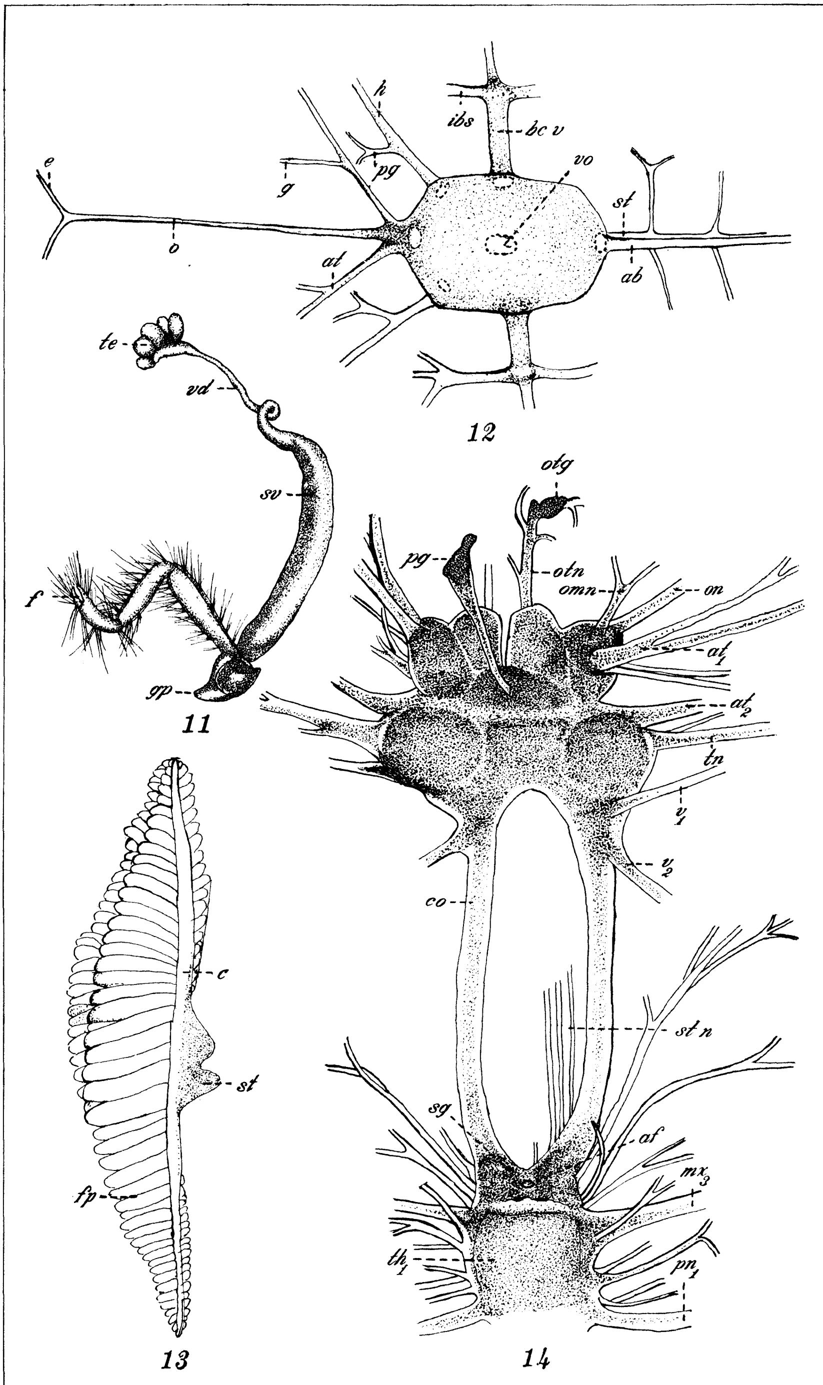

PLATE 3. REMIPES TESTUDINARIUS LATREILLE.

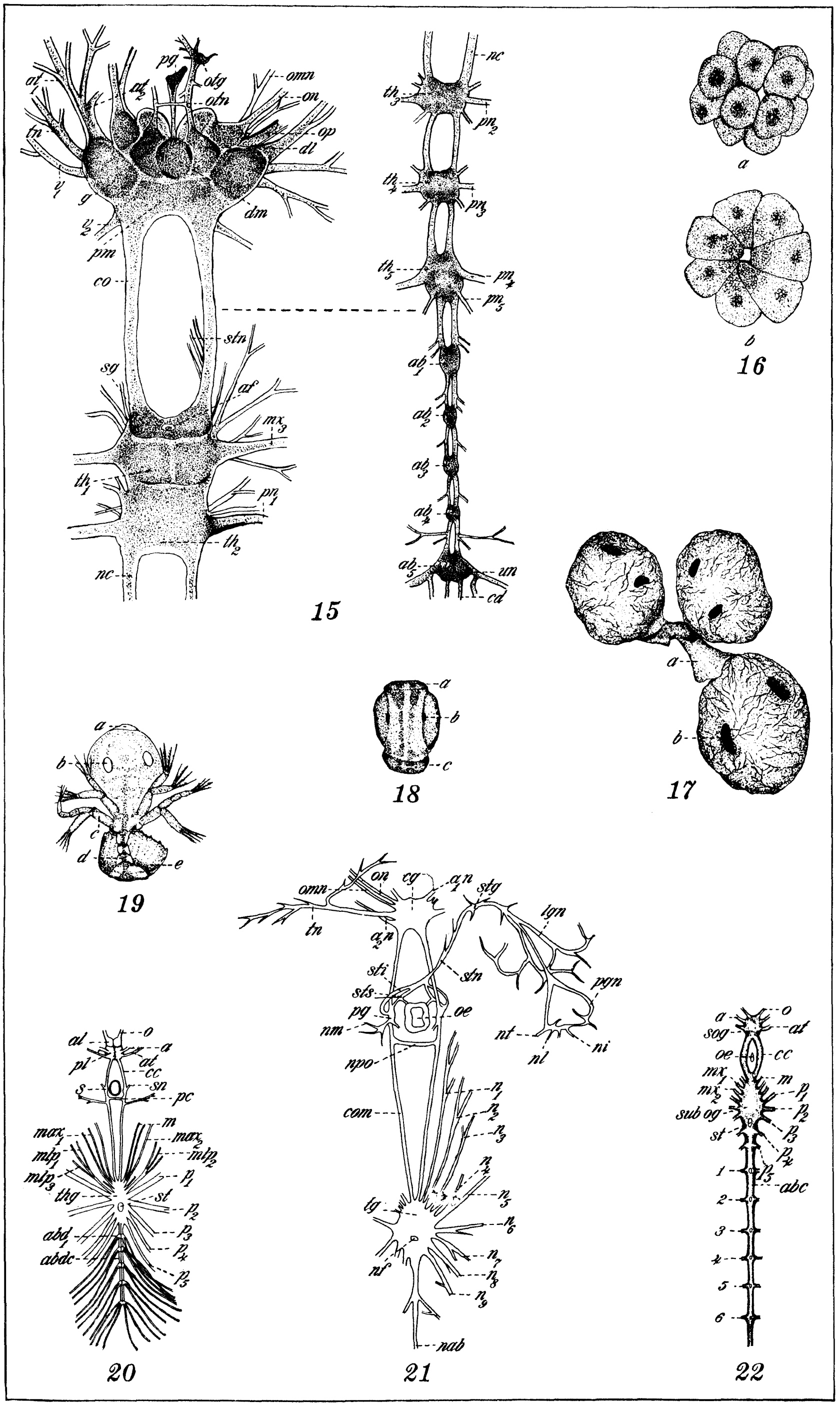

PLATE 4. REMIPES TESTUDINARIUS LATREILLE.

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Cytological Technique. By John R. Baker. London, Methuen & Co. Ltd., 1933. 131 pp., illus. Price, 3s. 6d.

Teachers and other persons interested in biology will find in this little book a brief authoritative discussion of the various techniques involved in the preparation of cells and tissues for microscopic examination. The chapters on fixation and staining, which comprise the bulk of the book, will be found most interesting by those desiring a basic knowledge of the composition and uses of some of the more common fixing fluids and staining reagents.

The book contains a number of bibliographic references.

—M. T.

1001 Garden Questions Answered. By Alfred Carl Hottes. New York, A. T. de la Mare Company, 1938. 2d Ed. 320 pp., illus.

In any garden various problems connected with soil, plants and their enemies, garden accessories, and weather are encountered. Prof. Alfred Carl Hottes furnishes solutions for most of them in his little book. Although the book is intended primarily for temperate or semitemperate climate, it includes some problems in tropical gardens. The plants treated are mostly of the temperate regions, but troubles of tropical plants similar to those of the temperate species and their remedies are found in the book, which also deals with difficulties in the culture of vegetables and ornamental annuals and trees.

The book is copiously illustrated with sketches and photographs, and well indexed. It is a valuable and handy manual for a gardener, especially for a beginner in gardening.

The calendar or advice on what to do in the garden each month, though useful, seems to be difficult to follow in the Tropics. However, it could serve as a guide in the preparation of a similar calendar for the Tropics.

In addition to ornamental gardening the book also discusses vegetables, fruits, and miscellaneous topics such as plant breeding, engineering, geometrical calculations, carpentry, and other routine necessary in keeping a garden. It should be of value to ornamental gardeners and to those who contemplate making a garden.—V. M. D.

Pneumonia and Serum Therapy. By Frederick T. Lord and Roderick Heffron. Revised Edition of Lobar Pneumonia and Serum Therapy. New York, The Commonwealth fund, 1938. 148 pp. Price, $1.

This book is a clear presentation of the investigation carried out by Dr. F. T. Lord on the treatment of the acute pulmonary disease known as pneumonia by its specific antipneumococcus serum. The first chapter offers thorough information about the control program that is being carried out by various government agencies to accomplish effective treatment and control of pneumonia.

It discusses fully the clinical manifestations of a typical case of pneumococcus pneumonia as well as the different types of the causative pneumococci. The author gives special attention to the symptomatology, pathogenesis, epidemiology, immunity, diagnosis, and treatment of this disease. The reader can also obtain a general idea concerning the methods of manufacturing antipneumococcus serum from horses and rabbits, as well as instructions regarding the correct technique for administering the antipneumococcus serum in the treatment of pneumonia. The book also gives all the indications and contra-indications in the use of serum therapy and its possible results.

This book is a valuable guide for physicians in the treatment of this disease.—P. J. A.

Industrial Minerals and Rocks (Nonmetallics other than Fuels). Edited by the Committee on the Industrial Minerals Volume, Samuel H. Dolbear, Chairman Oliver Bowles, Vice-chairman, and others. Sponsored by the Seeley W. Mudd Memorial Fund. New York, The American Institute of Mining and Metallurgical Engineers, 1937. 955 pp., front., illus. Price, $6.

This new volume is a valuable contribution to existing literature on nonmetallic industrial minerals and rocks, except mineral fuels. Each chapter contains comprehensive information pertaining to the geologic occurrence, geographic distribution, political and economic control, production and consumption, method of mining, preparation for market, industrial uses, marketing, and prices. It is reported that not less than 70 of these

minerals, commonly known as "nonmetallics," are mined and used in industry.

It is pointed out that, while these nonmetallics rapidly increase in importance, many of their superficial deposits face a gradual exhaustion. To cope with that situation and to effect a profitable exploitation of these resources, more elaborate and effective methods of mining and processing are urged. These will require the employment of well-trained technical men to manage the operations.

To assist students and young engineers to take advantage of the opportunities in this broad and fertile field is one of the purposes behind the publication of this volume which was sponsored by the Seeley W. Mudd Memorial Fund. Each chapter is written by a specialist on the subject. There is a bibliography at the end of each chapter. This book will be useful to engineers, technologists, business men, and students in the mineral industries.—B. R. S.

Metallurgy. By Carl G. Johnson, R. S. Dean, and J. L. Gregg. Chicago, American Technical Society, 1938. 149 pp., front., illus. Price, $1.50.

This book is essentially a compilation of available up-to-date knowledge pertaining to the manufacture and behaviour of metals and alloys. The important physical aspects of metallurgy, such as constitutional diagrams, shaping operations, and the physical and chemical properties of metals resulting from the hot and cold treatments, have been stressed, rather than the chemical process of melting and refining. Most of the modern equipment used is briefly described. An interesting discussion in the latter part of the book deals with the powder process of manufacturing alloys by the application of pressure and heat treatment. By this process it is now possible to manufacture many mixtures of metals which cannot be prepared by the usual melting process, especially metals whose melting points are higher than that of any known refractory.

This book is well illustrated, nontheoretical, and written in a style and language interesting and easy to understand. Laymen and students of engineering will find in this text a practical and valuable guide.—B. R. S.

The Environment and Its Effects Upon Man. Symposium held at Harvard School of Public Health August 24–August 29, 1936, as part of the Harvard University Tercentenary Celebration 1636–1936. Boston, Harvard School of Public Health, 1937. 297 pp., illus.

The book touches on the effects of social environment; industrial fatigue; air-borne infection; effect of heat and humidity and various abnormal conditions in industry, and methods of control; air conditioning; and organization of laboratories of industrial toxicology and hygiene.

These collected works should be read by public health workers and teachers of hygiene and preventive medicine, especially by those who are interested in the application of physiology to the prevention and control of ill health and inefficiency among industrial workers.

The treatment of the many aspects of industrial physiology and hygiene is most frank and thought provoking.

References are found at the end of each work.—M. L.

A Symposium of Cancer. By Leiv Kreyberg and others. Madison, University of Wisconsin Press, 1938. 212 pp. Price, $3.

This book contains papers dealing with the different aspects of cancerology. It gives the reader an insight into the results of investigations in experimental biology made in recent years which throw some light on the causation and production of cancer; clinical facts dealing with radiotherapeutics as worked out and observed by Coutard, and some points with regard to cancer as a public-health problem. The authors mention also the influence of wave lengths of radiation to the disease. In short, the book brings to us the work, observations, and experiences of a well-known group of men competent to discuss cancer.—P. S. C.

On Your Guard! The Prevention and Treatment of Sex Diseases. By Carl Warren. Foreword by M. J. Exner. New York, Emerson Books, Inc., 1937. 160 pp., front., illus. Price, $1.

This little book on sex hygiene is written in a language very understandable to the layman.

The work touches in an interesting manner, amongst other things, on the incidence of venereal diseases by geography, sex, age, occupation, economic status, and race; venereal prophylaxis; proper ways to obtain, test, and handle mechanical preventive devices; symptoms and treatment of venereal diseases; and how to avoid the perils of quacks and nostrums.

The book includes many illustrations.—H. L.

RECEIVED

American medical association interns' manual. Edited by the council on medical education and hospitals and the council on pharmacy and chemistry of the American medical association. Chicago, American medical association, 1938. 229 pp.

American medical association. New and nonofficial remedies, 1938, containing descriptions of the articles which stand accepted by the council on pharmacy and chemistry of the American medical association on January 1, 1938. Chicago, American medical association, 1938. 590 pp., biblio., index.

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DOLBEAR, SAMUEL H., and others, ed. Industrial minerals and rocks (nonmetallic other than fuels). Sponsored by the Seeley W. Mudd memorial fund. New York, The American institute of mining and metallurgical engineers, 1937. 955 pp., front., illus. Price, $6.

DUBLIN, LOUIS I., and ALFRED J. LOTKA. Twenty-five years of health progress. A study of the mortality experience among the industrial policyholders of the Metropolitan Life Insurance Company, 1911 to 1935. New York, Metropolitan Life Insurance Company, 1937. 611 pp., illus.

GUNTON, H. C. Nature study above and below the surface. A bridge between amateur and professional. With a preface by Dr. C. B. Williams, M. A., D. Sc. London, H. F. & G. Witherby, ltd., 1938. 134 pp., pl., illus. Price, 7s. 6d.

HATCHER, ROBERT A., and others. Epitome of the pharmacopeia of the United States and the national formulary with comments corrected and revised in accordance with the first supplement of the pharmacopeia, eleventh revision, and the first and second correction lists of the national formulary, sixth edition. Prepared for the use of physicians under authorization of the council on pharmacy and chemistry of the American medical association by a committee of council members: Robert A. Hatcher, Ernest E. Irons, Torald Sollmann, Paul Nicholas Leech. Chicago, American medical association, 1938. 244 pp.

HATCHER, ROBERT A. Useful drugs. A selected list of essential drugs with brief discussions of actions, uses, and dosage. Edited under the direction and supervision of the council on pharmacy and chemistry of the American medical association. Chicago, American medical association, 1938. 11th ed. 258 pp. Price, $0.75.

JOHNSON, CARL G., R. S. DEAN, and J. L. GREGG. Metallurgy. Chicago, American technical society, 1938. 149 pp., illus. Price, $1.50.

NORTON, L. J. Financing agriculture. Danville, Illinois, The Interstate printing Co., 1938. 321 pp., illus. Price, $2.75.

PERKINS, WILLIAM HARVEY. Cause and prevention of disease. Philadelphia, Lea & Febiger, 1938. 713 pp. Price, $7.50.

ROBERTS, HARRY. The troubled mind. A general account of the human mind, and its disorders and their remedies. With chapters on the

insanities by Margaret Nelson Jackson. London, John Murray, 1938. 284 pp. Price, 6s.

RYAN, W. CARSON. Mental health through education. New York, The Commonwealth fund, 1938. 315 pp. Price, $1.50.

SUTHERLAND, JOHN PRESTON. Malnutrition the medical octopus. Boston, Meador publishing Co., 1937. 368 pp. Price, $3.

SWELLENGREBEL, N. H., and A. DE BUCK. Malaria in the Netherlands. Amsterdam, Scheltema & Holkema, ltd., 1938. 267 pp., illus.

VAN REENEN, REENEN J. Resisting drought. Pretoria, The Government printer, 1935. 221 pp., front., illus.

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THE PHILIPPINE JOURNAL OF SCIENCE

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STUDIES ON PHILIPPINE KINGFISHERS, I

GENUS CEYX

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ONE PLATE

In connection with the recording of the birds kept in the collection of the Philippine Bureau of Science, the different groups represented in this collection are being studied. Accordingly, a few papers on Philippine pigeons [1] have been published. While awaiting more material to complete my studies on Philippine pigeons, I have been collecting data on Philippine kingfishers, and the present paper is the first of a series on this group.

The kingfishers form a distinct group of birds characterized by comparatively long, stout, and pointed bill; culmen rounded or slightly flattened; feet weak; fourth toe united with third on its greater length, second, when present, united with third on its basal third. These birds comprise the family Alcedinidæ.

The literature on Philippine kingfishers of the Genus *Ceyx* is scattered through various publications, in a number of which confusion with regard to the position of the birds treated is very apparent. In the present paper an attempt is made to record and discuss the data obtained from first-hand studies of Philippine material, and to correlate these data with those appearing in other publications.

The material upon which the results of the present study are based is in the collection of birds of the Philippine Bureau of Science, Manila.

[1] Philip. Journ. Sci. 59 (1936) 289–305, 327–336; 60 (1936) 157–163, 407–419; 63 (1937) 175–184.

A new race of *Ceyx erithacus* is described.

I wish to express here my gratitude to the Raffles Museum at Singapore through its acting Director, M. W. F. Tweedie, for the specimens lent me for comparison with Philippine material.

Genus CEYX Lacépède, 1799

Brightly colored three-toed kingfishers; tail short and rounded; bill not grooved; culmen straight, slightly flattened at base; first primary reaching nearly to tips of longest quills.

Six species of the genus occurring in the Philippines are herein treated.

Key to the species of Ceyx.

*a*¹. Largely black above .... *C. argentatus.*
*a*². Not black above.
  *b*¹. Breast with a blue area .... *C. cyanopectus.*
  *b*². Breast without a blue area.
    *c*¹. Upperside largely blue .... *C. lepidus.*
    *c*². Upperside largely rufous.
      *d*¹. Underside lilac-rufous .... *C. melanurus.*
      *d*². Underside yellow.
        *e*¹. With a blue ear patch .... *C. erithacus.*
        *e*². Without a blue ear patch .... *C. rufidorsus.*

Species 1. CEYX ARGENTATUS

Largely black above, with big silvery white spots; chin, throat, and forebreast occasionally with a buffish wash; rest of underparts black, with a hue of blue; bill black.

CEYX ARGENTATUS ARGENTATUS Tweeddale.

Ceyx argentata TWEEDDALE, Ann. & Mag. Nat. Hist. IV 20 (1877) 533.

Alcyone cyanopecta MCGREGOR and WORCESTER, Hand-list Bds. Philip. Is. (1906) 52.

Ceyx argentatus argentatus HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 132.

Basilan, Dinagat, Mindanao.

Specimens from Mindanao were examined.

Measurements of Ceyx argentatus argentatus, based on fifteen males and eleven females.

	Extremes. mm.	mode. mm.
Wing	58–65	61
Tail	22–27	24
Culmen from nostril	30–35	33
Tarsus	7– 9	8
Middle toe and claw	15–17	17

The black area below has a hue of Berlin blue on breast and sides of abdomen.

CEYX ARGENTATUS FLUMENICOLUS Steere.

Ceyx flumenicola STEERE, List Birds and Mammals Steere Exped. (1890) 10.
Alcyone flumenicola MCGREGOR and WORCESTER, Hand-list Bds. Philip. Is. (1906) 53.
Ceyx argentatus flumenicolus HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 133.

Leyte and Samar.

Specimens from Leyte and Samar were examined.

Measurements of Ceyx argentatus flumenicolus, based on fourteen males and five females.

	Extremes. mm.	mode. mm.
Wing	56–61	58
Tail	20–24	23
Culmen from nostril	29–32	30
Tarsus	7– 9	8
Middle toe and claw	15–17	16

The black area on breast and sides of abdomen has an azurite blue wash.

Species 2. CEYX CYANOPECTUS

General color of upper surface blue; head and secondary coverts spotted with cobalt; back, rump, and upper tail coverts cobalt; underside largely reddish buff with at least (female) an incomplete band of blue on breast. Male with two blue bands on breast which meet on sides, enclosing a semicircular reddish buff area.

CEYX CYANOPECTUS CYANOPECTUS Lafresnaye.

Ceyx cyanopectus LAFRESNAYE, Rev. Zool. (Soc. Cuv.) 3 (1840) 33.
Alcyone cyanopectus JARDINE, Contrib. Ornith. (1850) 82.
Alcyone cincta JARDINE, Contrib. Ornith. (1850) 82, pl. only.
Ceyx philippinensis GOULD, Proc. Zool. Soc. London (1868) 404.
Ceyx steerii SHARPE, Cat. Bds. Brit. Mus. 17 (1892) 187.
Ceyx cyanopectus cyanopectus HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 127.

Luzon, Marinduque, Masbate, Mindoro, Polillo, Sibuyan, Ticao.

Specimens from these islands were examined.

Measurements of Ceyx cyanopectus cyanopectus, based on twenty-seven males and twenty-one females.

	Extremes. mm.	Mode. mm.
Wing	58–62	60
Tail	21–23	23
Culmen from nostril	29–34	32
Tarsus	8– 9	8
Middle toe and claw	16–18	17

Closely resembles *Ceyx cyanopectus nigrirostris*, from which it may be distinguished in having a lighter tint of buff below, a red lower mandible, and smaller spots of cobalt on head and hind neck.

CEYX CYANOPECTUS NIGRIROSTRIS Bourns and Worcester.

Ceyx nigrirostris BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 94.

Alcyone nigrirostris MCGREGOR and WORCESTER, Hand-list Bds. Philip. Is. (1906) 53.

Ceyx cyanopectus nigrirostris HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 128.

Measurements of Ceyx cyanopectus nigrirostris, based on one male and one female, respectively.

	Male. mm.	Female. mm.
Wing	58	58
Tail	23	23
Culmen from nostril	30	30
Tarsus	8	8
Middle toe and claw	16	17

This race may be confused with its closest ally, *Ceyx cyanopectus cyanopectus*, from which it is easily distinguished by its entirely black bill, larger spots of cobalt on head and hind neck, and darker buff on underside.

Species 3. CEYX LEPIDUS

CEYX LEPIDUS MARGARETHÆ Blasius.

Ceyx margarethæ BLASIUS, Braunschweigischer Anzeiger (April 15, 1890).

Ceyx suluensis BLASIUS, Journ. für. Orn. (1890) 141.

Ceyx bournsi STEERE, List Birds and Mamm. Steere Exped. Philippines (1890) 11.

Ceyx Malamaui STEERE, ibid.

Banton, Basilan, Bongao, Cebu, Mindanao, Negros, Romblon, Sibuyan, Siquijor, Sulu, Tablas, Tawitawi.

Specimens from Basilan and Negros were examined.

Measurements of Ceyx lepidus margarethæ, based on two females from Basilan and Negros, respectively.

	mm.	mm.
Wing	64	62
Tail	22	22
Culmen from nostril	28	
Tarsus	8	8
Middle toe and claw	16	16

Upper surface with a base color of black; on head and neck this color almost entirely and evenly covered with spots of ultramarine, at tip of each feather; wing coverts, back, rump, and tail irregularly washed with ultramarine; lores, sides of throat, and underparts, except chin, throat, and midabdomen, orange rufous; chin and throat white, washed with orange; bill and feet coral red.

In allying *C. margarethæ* with *C. lepidus* I am following Hachisuka's arrangement, corroborated by descriptions in available literature, principally that by Sharpe;[2] I regret that a specimen of *Ceyx lepidus lepidus* has not been examined.

No specimen of *Ceyx goodfellowi* Ogilvie-Grant, which Hachisuka referred as another subspecies of *C. lepidus,* has been examined.

Species 4. CEYX MELANURUS

Above largely rufous, deeper shaded than under surface; head spotted with lilac; eyelid black greatly developed on anterior half; ear coverts rufous, with a white spot behind; quills black; chin and throat white; bill and feet scarlet.

CEYX MELANURUS MELANURUS Kaup.

Ceyx melanura KAUP, Fam. Eisv. (1848) 15.

Ceyx melanurus melanurus HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 130.

Luzon, Polillo.

Specimens from Alabat, Luzon, and Polillo were examined.

Measurements of Ceyx melanurus melanurus, based on three males and six females.

	Extremes. mm.	Mode. mm.
Wing	53–56	55
Tail	19–21	19
Culmen from nostril	25–31	29
Tarsus	7– 8	8
Middle toe and claw	15–16	16

[2] Catalogue of Birds I 17 (1892).

Breast and flanks rufous with a sheen of lilac, spots of lilac on head indistinct, wing coverts spotted with blue-violet.

CEYX MELANURUS SAMARENSIS Steere.

Ceyx samarensis STEERE, List Birds and Mammals Steere Exped. (1890) 10.
Ceyx melanurus samarensis HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 130.

Leyte, Samar.

Specimens from these islands were examined.

Measurements of Ceyx melanurus samarensis, based on one male from Leyte and one female from Samar, respectively.

	Male. mm.	Female. mm.
Wing	60	60
Tail	21	21
Culmen from nostril	29	26
Tarsus	8	8
Middle toe and claw	15	15

Spots of lilac on head indistinct; blue-violet spots on wing coverts larger than in *C. m. melanurus;* breast and upper abdomen deep rufous, like back, washed with lilac in male; lighter with yellow hue in female.

CEYX MELANURUS MINDANENSIS Steere.

Ceyx melanura SHARPE, Trans. Linn. Soc. London pt. 6 1 (1877) 317.
Ceyx mindanensis STEERE, List Birds and Mammals Steere Exped. (1890) 10.
Ceyx basilanica STEERE, ibid.
Ceyx platenæ BLASIUS, Journ. für. Orn. (1890) 148.
Ceyx melanurus mindanensis HACHISUKA, Bds. Philip. Is. pt. 3 (1934) 131.

Basilan, Mindanao.

Specimens from Basilan and Mindanao were examined.

Measurements of Ceyx melanurus mindanensis, based on three males and four females.

	Extremes. mm.	mode. mm.
Wing	57–60	60
Tail	20–21	20
Culmen from nostril	31–33	32
Tarsus	8– 9	8
Middle toe and claw	16–18	17

Spots of lilac on head heavy, spots of lilac on wing coverts replacing blue-violet of *C. m. melanurus* and *C. m. samarensis;* color of under parts as in *C. m. melanurus.*

Species 5. CEYX ERITHACUS

In the examination of kingfishers in the collection of birds of the Bureau of Science, Manila, two specimens of red-backed three-toed kingfishers from Mindoro were noted to have a blue ear patch which is absent in those obtained in Busuanga and Palawan. This and other characters prove it to be a new race of *Ceyx erithacus*, which I propose to call:

CEYX ERITHACUS VARGASI subsp. nov. Plate 1.

Type.—Adult female, Bur. Sci. 1733, Puerto Galera, Mindoro, Philippine Islands, November 26, 1902, *R. C. McGregor and Andres Celestino.*

From *Ceyx rufidorsus* Strickland, of Borneo, North Natuna, Palawan, and Busuanga this species differs in having two black frontal spots, one on either side of the culmen, a much larger blue patch above the ear coverts, and black scapulars, but some of the black scapulars on the surface are washed with blue. It closely resembles *Ceyx erithacus motleyi* Chasen and Kloss, but its mantle has only a light tint of lilac and its scapulars have less blue.

The measurements in millimeters of the holotype and the paratype, respectively, are as follows: Wing 55, 59; tail 22, 23; culmen from nostril 30, 32; tarsus 8, 8; middle toe and claw 17, 16.

MATERIAL

Ceyx rufidorsus rufidorsus: 2 males and 2 females from Borneo; 1 male from N. Natuna; 2 males and 2 females from Palawan; 2 males and 1 female from Busuanga. *Ceyx erithacus erithacus:* 1 male and 1 female from Singapore; 1 male from Kuala Lumpur and 1 female from Negri Sembilan, Pahang Border. *Ceyx erithacus motleyi:* 2 males (type and paratype), 2 females from Bettotan, near Sandakan, Borneo, and 2 females from Mount Kinabalu.

Ceyx rufidorsus (= *C. eurythra*) was reported from Mindoro by Hartert (1891) and by Worcester and Bourns (1898). McGregor and Celestino also collected a bird which the former identified as *C. eurythra.* That bird is the holotype of the new race under consideration. The confusion arising from the original descriptions of *C. erithacus* (= *C. tridactyla*) and of *C. rufidorsus* which was noted by Strickland (1846) and later by Hartert (1902) may have mislead many ornithologists including Hartert (1891) himself, Worcester and Bourns (1898), and McGregor in identifying the Mindoro form.

I take pleasure in naming this bird for the Honorable Jorge B. Vargas, whose interest is largely responsible for the furtherance of studies on Philippine birds.

Species 6. CEYX RUFIDORSUS

CEYX RUFIDORSUS RUFIDORSUS Strickland.

Ceyx rufidorsus SHARPE, Ibis (1884) 318.
Ceyx eurythra SHARPE, Cat. Bds. Brit. Mus. 17 (1892) 179.

Balabac, Bongao, Calamianes, Mindoro, Palawan, Tawitawi. Specimens were examined from Busuanga and Palawan.

Measurements of Ceyx rufidorsus rufidorsus, based on four males and three females.

	Extremes. mm.	mode. mm.
Wing	57–61	57 (58)
Tail	21–23	23
Culmen from nostril	30–31	30
Tarsus	8	8
Middle toe and claw	17	17

Deep rufous above, with lilac wash very prominent on head, back, and rump. Underparts lemon-yellow, with a shade of rufous; chin and throat white, with lemon-yellow hue.

The papers of Laubmann (1924, 1931) and of Chasen and Kloss (1929) are important in the determination of *Ceyx erithacus*, *C. rufidorsus*, and other forms of the Genus *Ceyx*.

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ILLUSTRATION

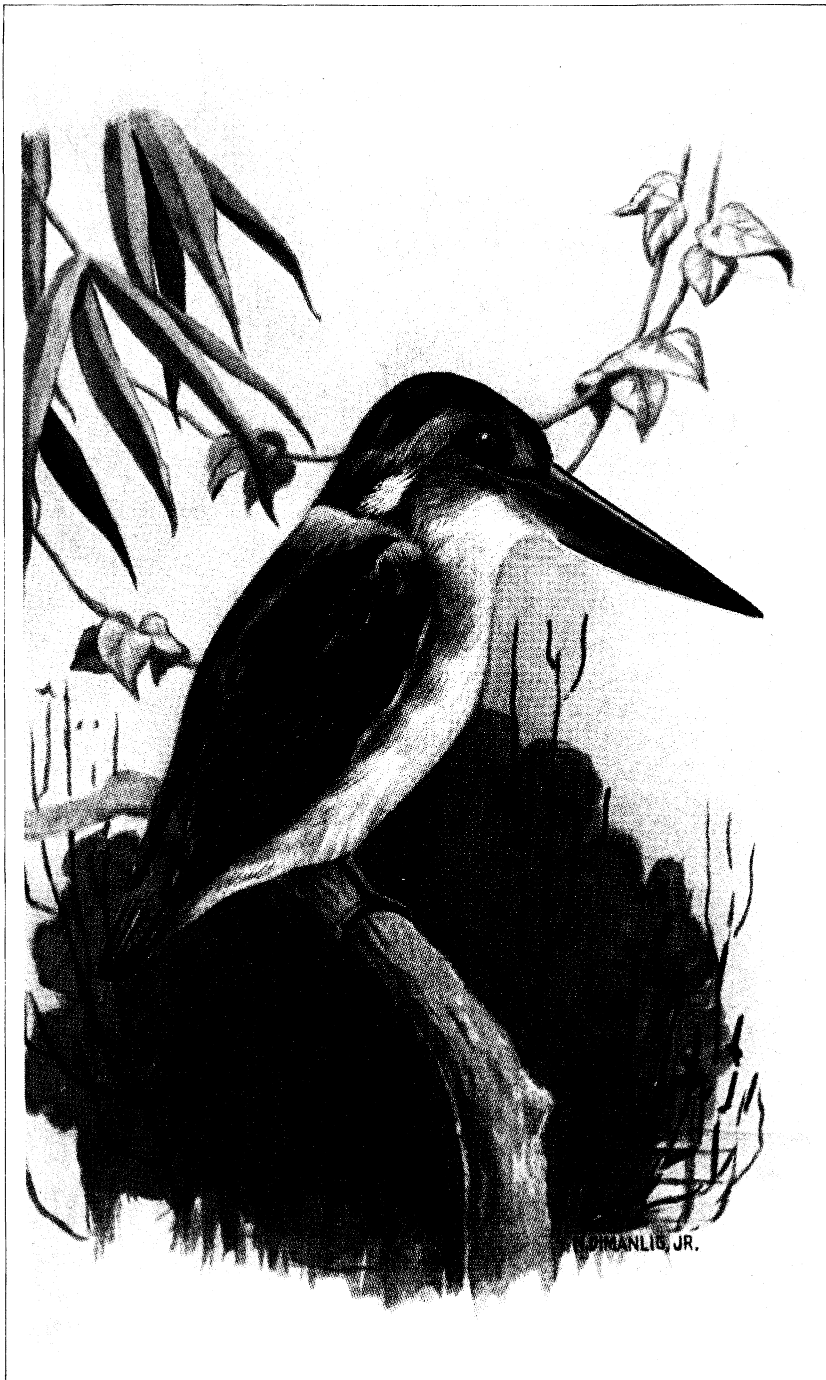

PLATE. 1. CEYX ERITHACUS VARGASI SUBSP. NOV.

SCIUROPTERUS MINDANENSIS SP. NOV., A NEW SPECIES OF FLYING SQUIRREL FROM MINDANAO

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FOUR PLATES

In August, 1937, Francisco S. Rivera and the writer collected eight specimens of a flying squirrel in the neighborhood of Badiangon, a small coastal barrio of Gingoog, Oriental Misamis Province, on the northern coast of Mindanao. As far as the writer can determine, this is the first record of the flying squirrel in the mainland of Mindanao, although R. C. McGregor and A. Celestino, in January, 1907, collected the only known specimen of *Sciuropterus crinitus* Hollister, now in the United States National Museum, in Basilan Island, off the southern tip of Zamboanga Peninsula. There has been no record of recapture of this species in Basilan Island, so that the present form from the mainland of Mindanao cannot be actually compared with the Basilan form, except through the written description. The present species was compared with Palawan forms, and found to differ very markedly from the latter.

It is strange that this animal is known only to the people who are residing in or very near the place of collection, as *kao-kag*, and totally unknown in the nearby towns. The rather bushy tail is utilized by the natives as a duster.

The species is nocturnal, spending the daytime in holes in tree trunks. One such abode was pointed out to us by a native who was very familiar with the habits of this animal.

The animal was collected in the evening, when individuals emerged from their hollows and descended to the shore regions to feed on the developing fruits of the coconut (*Cocos nucifera* Linn.), santol [*Sandoricum koetjape* (Burm. f.) Merr.], and durian (*Durio zibethinus* Murr.). Even from a distance one could easily detect the presence of the animal in a particular tree by its peculiar loud whistling-hissing note, although locating it definitely among the branches was another problem.

The writer proposes the name *Sciuropterus mindanensis* for this new form after the name of the island where it was discovered.

The writer is greatly indebted to Dr. Gerrit S. Miller Jr., Curator of the Division of Mammals, United States National Museum, for going over this manuscript and making comparisons of a paratype of the present species with the type specimen of *Sciuropterus crinitus* Hollister.

SCIUROPTERUS MINDANENSIS sp. nov.

Described from Nos. 223, cotype male, and 224, cotype female, Bureau of Science Collection, collected at Badiangon, Gingoog, Oriental Misamis Province, northern coast of Mindanao, August 1, 1937 (*D. S. Rabor and F. S. Rivera*).

Adult male.—Externally somewhat resembling *Sciuropterus crinitus* Hollister, but very much larger and darker; ears very small, inner surface for the most part naked, except for a few fine hairs; outer surface naked distally, well furred on basal third; three prominent long tufts of hair projecting from ear conch, one from below and one from each side, anterior tuft tending to fuse imperceptibly with that below; a prominent, roughly crescent-shaped blackish collar extending from behind ears to back of neck; vibrissæ coarse, elongate, reaching easily beyond ears, longest hair 60 millimeters; fur on forehead short, 12 to 14 millimeters, longest 17; on neck, 12 to 16 millimeters, longest 18; on back, 25 to 35 millimeters, on patagium of similar length as those of back and sides, but thinner and nicely arranged in definite longitudinal rows with alternate rows of naked skin between; edge of wing membrane with a fringe of very fine dense hair, 8 to 10 millimeters in middle span, 15 millimeters near attachment to foot, in color contrasting sharply with other portions of membrane; on ankle fur shorter than on legs; tail somewhat flattened, hair 42 to 45 millimeters near base, 32 to 35 millimeters near distal portion, 45 to 48 millimeters at tip; belly thin-haired, longest hair rarely exceeding 22 millimeters; outer longer hair straight, shorter underfur woolly on back.

Ears brownish at tips; upper and lower lips blackish brown; cheek buffy brown; postauricular regions pure buff; throat buffy. Body grizzled chestnut-auburn above, many hairs tipped with blackish, especially along middle of back, becoming fewer at sides; underfur slate to slate-gray at base, lighter at tips; head, especially forehead and crown, similar to back, with sides of

face and neck buffy brown, many hairs black or brownish black at tips, bases slate-gray; hairs in crescent-shaped blackish collar, long, slate-black at tips and slate-gray at bases, with underfur same as in surrounding regions; patagium, hairs above slate-black to blackish slate at base and pale chestnut at tips; hair at edge of membrane slate-black at base and brownish buff at tips; hair on underparts of body and limbs for the most part buffy, underfur gray; hair on scrotum pure chestnut to amber-brown, forming a distinct splotch of color on buffy underside of body; tail at base, above, and at sides brownish, some hairs tipped with black but with gray bases like others; first proximal fourth of tail, like base, a little darkened distally by increase in black portion of some hairs and by increase in number of black-tipped hairs, with basal color changing to brownish gray; distal three-fourths much darker than proximal portion, blackish color becoming more intense as it progresses distally, almost solid black at tip; tail at base, below, brownish buff, extreme tips of hairs blackish, basal color grayish; buffish color continuing on underside of tail for nearly its whole proximal fifth and along narrow median line; most distal fifth of tail uniformly blackish, like sides and back; ear tufts buff at bases, blackish at tips; vibrissæ elongate, black.

Adult female.—Externally similar to male, with corresponding splotch of pure chestnut to amber-brown around external genitalia and anal region.

SKULL AND TEETH (FROM SKULL AND TEETH OF COTYPE MALE)

Skull resembling that of other Philippine members of the genus *Sciuropterus,* but much larger.

Upper incisors elongate; combined width at tip, 5 millimeters; length of exposed portion, 9.5; total length of an extracted tooth following curve, 31. First upper premolar very small, inserted at a strong angle, root extending backward against that of second premolar. Second premolar large, molariform, enamel folded and ridged, forming three prominent outer cusps; enamel on sides of ridges rather beaded and pitted; on first and second molars the folds extending across teeth only halfway or a little more; both molars with two prominent outer cusps; inner surface rather depressed. Third molar with one prominent outer cusp. First premolar with only one root; second premolar with three roots; first molar with three roots; second molar with four

roots; third molar with three roots; in each of the large cheek teeth inside root stoutest, outside roots slender except those of last molar in which both inside and posterior outside roots are stout; last two molars with crowns tending to turn outward.

Lower incisors elongate; combined width at tip, 5 millimeters; length of exposed portion, 16; total length of an extracted tooth following curve, 34. First lower premolar about three-fourths as large as first molar, enamel folded, anterior fold running completely across tooth, leaving two prominent cusps and a small accessory cusp between them on outer edge; each molar with a small accessory cusp between the two prominent cusps on outer edge; inner surface depressed; all lower cheek teeth with two not strongly-defined cusps on inner edge (anterior cusp more developed) and a minute intermediate cusp; first premolar with two roots, the posterior very stout, clearly suggesting fusion of two original roots; each molar with four well-defined roots (a very tiny fifth root was found between the posterior root pair of the first molar on left side), with posterior outer root of each molar stoutest.

Measurements of the cotypes of Sciuropterus mindanensis sp. nov.

	No. 223, male. mm.	No. 224, female. mm.
Total length	810	790
Tail	440	460
Hind foot	70	70
Ear from meatus, vertical	20	20
Length of ear tufts	36	36
Skull:		
Upper length	72	71.5
Basal length	68	67
Zygomatic breadth	43	41.1
Nasals, length	22	22
Nasals, greatest breadth	10	9.5
Frontal length	27.5	27.5
Interorbital breadth	17.7	18
Postorbital breadth	12	12
Vertical diameter of orbit	15.2	15
Breadth between tips of postorbital processes	28	28
Palate	32	32
Diastema, upper	15.4	15.2
Diastema, lower	9	9.5
Length of upper tooth series	14.5	14.8
Length of four large teeth	13.6	13.4
Length of mandible to condyle	44.1	43.8
Length from incisor tip to condyle	50	48.5
Lower tooth row	15.2	14

The intensity of the coloration on the back varies with age, the younger specimens being not as intensely colored as the older. Likewise, the crescent-shaped blackish collar varies in extent and depth of coloration with age, being larger in extent and deeper in intensity in older animals, and almost absent in young specimens. In one specimen (male, B. S. No. 226) the chestnut coloration of the scrotal region extends all over the anal area and the underside of the hind limbs, becoming a bit paler in these parts.

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ILLUSTRATIONS

PLATE 1

Sciuropterus mindanensis sp. nov.; male cotype, B. S. No. 223.

PLATE 2

Sciuropterus mindanensis sp. nov.; female cotype, B. S. No. 224.

PLATE 3. SCIUROPTERUS MINDANENSIS SP. NOV.

FIG. 1. Male cotype, skull, dorsal view; × 1.
2. Male cotype, skull, ventral view; × 1.
3. Male cotype, lower jaw, superior view; × 1.
4. Male cotype, lower jaw, lateral view; × 1.

PLATE 4. SCIUROPTERUS MINDANENSIS SP. NOV.

FIG. 1. Female cotype, skull, dorsal view; × 1.
2. Female cotype, skull, ventral view; × 1.
3. Female cotype, lower jaw, superior view; × 1.
4. Female cotype, lower jaw, lateral view; × 1.

PLATE 1. SCIUROPTERUS MINDANENSIS SP. NOV.

PLATE 2. SCIUROPTERUS MINDANENSIS SP. NOV.

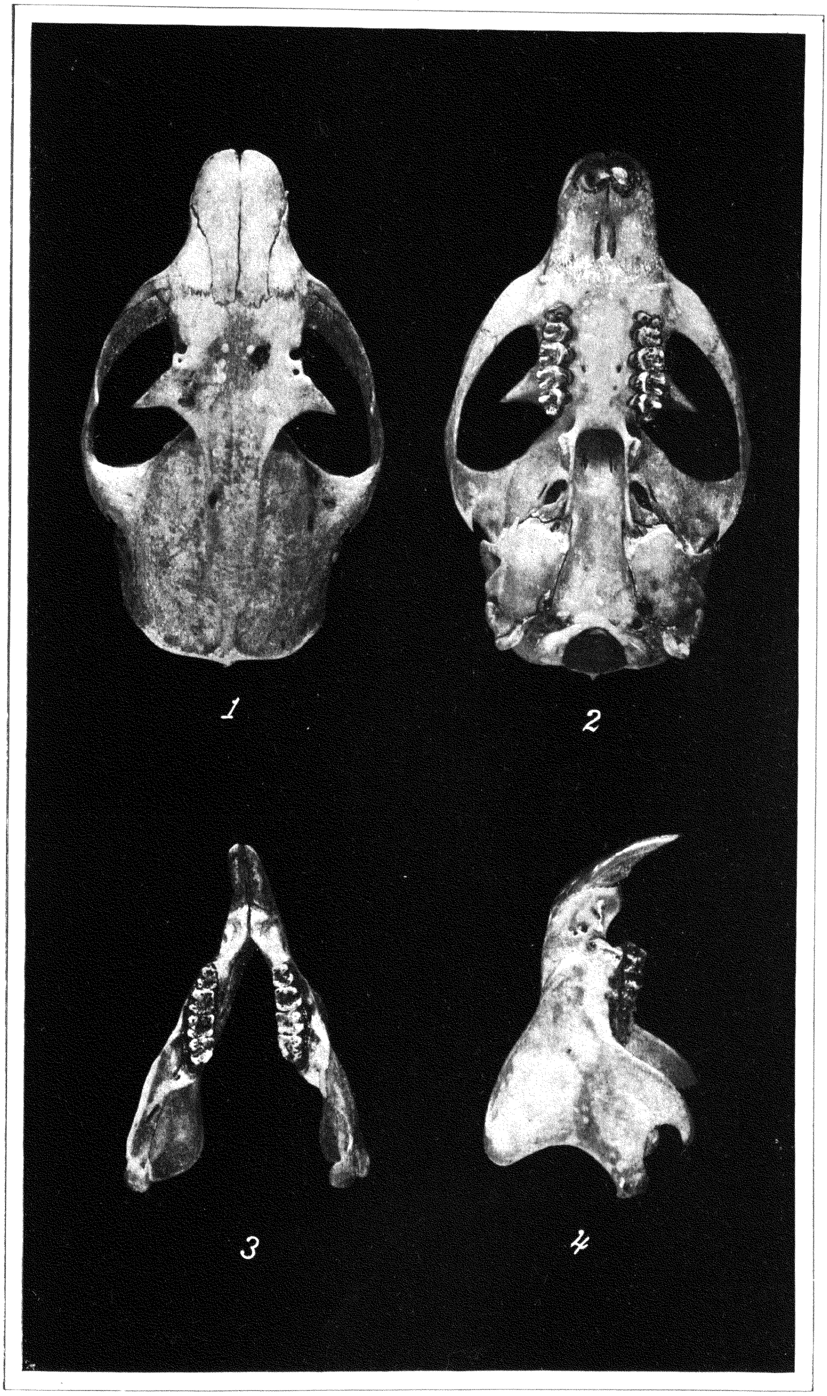

PLATE 3. SCIUROPTERUS MINDANENSIS SP. NOV.

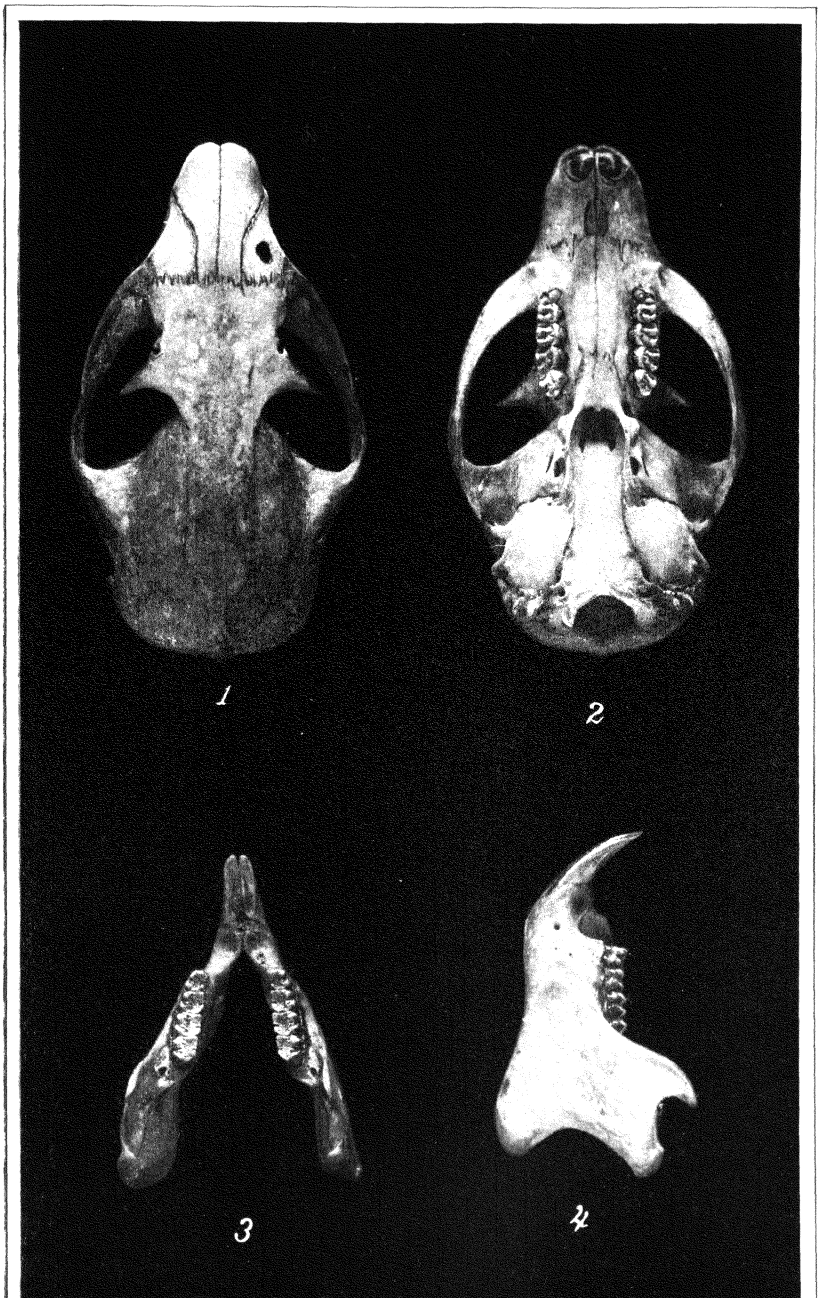

PLATE 4. SCIURUPTERUS MINDANENSIS SP. NOV.

THE PUKOT FISHERIES OF LAGUNA DE BAY

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TWO PLATES AND FIVE TEXT FIGURES

In August, 1938, the writers had occasion to check certain observations and data relative to the pukot fisheries of Laguna de Bay; the greater part of the present report has been based upon the results of this study. Additional data on the pukot have also been gathered. Among the things discussed in this report are: (*a*) the pukot and its operation; (*b*) the pukot in relation to the kanduli fisheries; and (*c*) suggestions for additional measures to increase the effectiveness of Fish and Game Administrative Order No. 3 for the conservation and rehabilitation of the kanduli fisheries of Laguna de Bay.

For the gathering of data a questionnaire in tabulated form was used, into which was entered the information gathered from fishermen, together with actual measurements made of pukot nets. The information called for in the questionnaire included: (*a*) kind of pukot; (*b*) name and residence of the pukot owner; (*c*) number of pieces (*banatan*) of the different sections of the net; length, width, kind of netting, size of ropes, and number of floats of each banatan; (*e*) depth of water in the lake where pukot may be operated; (*f*) number of fishermen necessary to operate the pukot; and (*g*) cost of the pukot outfit. This information, together with other data gathered, was placed in separate tables, charts, and graphs.

The pukot is apparently the most important and most effective fishing gear in Laguna de Bay. It catches all the fish in the area it encloses except the very small ones that can pass through the meshes of its *tarupit*. Records of catches compiled show that a large pukot (*pukot laot*) is capable of catching in a single haul, fish, mostly kanduli, worth 1,000 pesos. Yet the average pukot catch, in recent years, has hardly been paying operation costs.

There are about 150 pukot in Laguna de Bay, valued at 95,000 pesos. To this amount may be added the cost of about 20 motor

boats used in towing the pukot to the fishing ground. Approximately 3,000 fishermen are directly engaged in the operation of pukot. Besides, some 1,000 persons acting as middlemen (*regatón*) depend on pukot for their trade, going to the pukot by sailboats to buy the catches which they sell in turn to fish vendors on land (Plate 2, fig. 3).

THE PUKOT AND ITS OPERATION

PUKOT LAOT

Description.—A pukot-laot outfit consists of two large bancas (each about 15 meters long, 1.5 meters wide, and 1 meter deep); three smaller bancas (each about 9 meters long, 1 meter wide, and 0.5 meter deep); and the pukot net.

One of the two large bancas, called *lambatan,* is used to hold the net, and into the other, the *dalagan,* the fishermen pull the net. Each is provided with an outrigger on only one side (usually the right) so that they can come close to each other during actual fishing operations. One of the small bancas, also with an outrigger, is used by the fishermen in driving bamboo poles into the bottom of the lake to which the bag of the net is tied. This banca is called the *buralan* or *pangipitan.* The two remaining small bancas, *alagaan,* are used by the divers for rest and to hold on to in the water.

The pukot is divided into sections composed of pieces of nettings called *banatan.* These sections are: (1) *tarupit;* (2) *panaklob;* (3) *pangkulong;* (4) *panglundo;* and (5) *pamaspas.* The netting of pukot is of the Aguinaldo standard.

The tarupit is of a single banatan of No. 23 or No. 6 cotton netting, somewhat rectangular in shape, about 10 meters long and 11 to 13 meters wide or deep. The bottom or sinker line is a double rope, while the float line is single. Both lines are of abacá rope 3.5 and 3 centimeters in circumference, respectively. The net is selvaged to the ropes with 5 to 10 meshes of No. 5 or No. 10 thread; the mesh stretched measures 3.5 centimeters. To the float line are attached 40 to 50 wooden floats, each about 10 centimeters long and 5 centimeters in diameter at the middle, and placed at intervals of about 20 centimeters. The free end of this section is selvaged to a double cotton rope to which are attached cotton rope rings at intervals of about 0.5 meter. By hauling in the bottom line this banatan is converted into a large dip net.

The panaklob is also of a single banatan. It is a rectangular net, twice as long as the tarupit but a little narrower. As the name suggests, it is used to cover the opening of the dip of the tarupit, thus enclosing the fish that may be contained in the net. The nettings, selvages, and sizes of the ropes are the same as those of the tarupit.

The pangkulong is composed of three banatan, each 50 to 65 meters (2,500 to 3,000 meshes) long and from 6 to 10 meters wide or deep. The netting is either of No. 6 or No. 14. The selvages and ropes used are the same as those of the tarupit and panaklob. To the float line are attached 100 to 150 floats at intervals of about 20 centimeters. This section is the portion of the pukot where the fish are concentrated before reaching the pocket or tarupit.

The panglundo consists of 22 to 30 banatan and each piece is made in the same manner as the pangkulong. In some pukot the different pieces of this section are made gradually narrower. The nettings have wider meshes of Nos. 18, 19, 24, or 31. This section is the one that drives the fish to the pangkulong.

The pamaspas consists of two to five pieces of nettings of larger meshes (No. 24 or No. 23) than that of the panglundo. The different pieces are also made gradually narrower. This section, the wing, is the first to be pulled in the process of hauling in the net.

Operation.—At the commencement of the fishing season or after each treatment of the net the different banatan are joined end to end. The different sections are in the following order: tarupit, panaklob, pangkulong, panglundo, and pamaspas.

A day before fishing the net is loaded in the lambatan in the reverse order so that the pamaspas is at the bottom and the tarupit at the top. Very early the following morning the pukot is taken to the fishing ground. Motor boats are used to tow the pukot outfit. Some pukot outfits, however, go to the fishing ground by rowing or sailing. Usually some men are sent ahead in a small banca to scout for schools of fish. When a school of fish is located, a flag is hoisted for the rest of the pukot outfit to follow.

On reaching the area to be fished, the men in the lambatan pay out the net in a circular form leaving a small opening of about 100 meters between the two ends. To each end is attached a brail where a big long rope is tied. The two big bancas take their positions about 100 meters from the ends of the net (text

fig. 1) and each anchors by means of a bamboo pole as *pamondo* or *barahan* driven to the bottom of the lake. Then the fishermen in both bancas begin to pull the ropes attached to the brail at each end of the net. The men on the dalagan pull the end of the tarupit and those on the lambatan pull the end of the

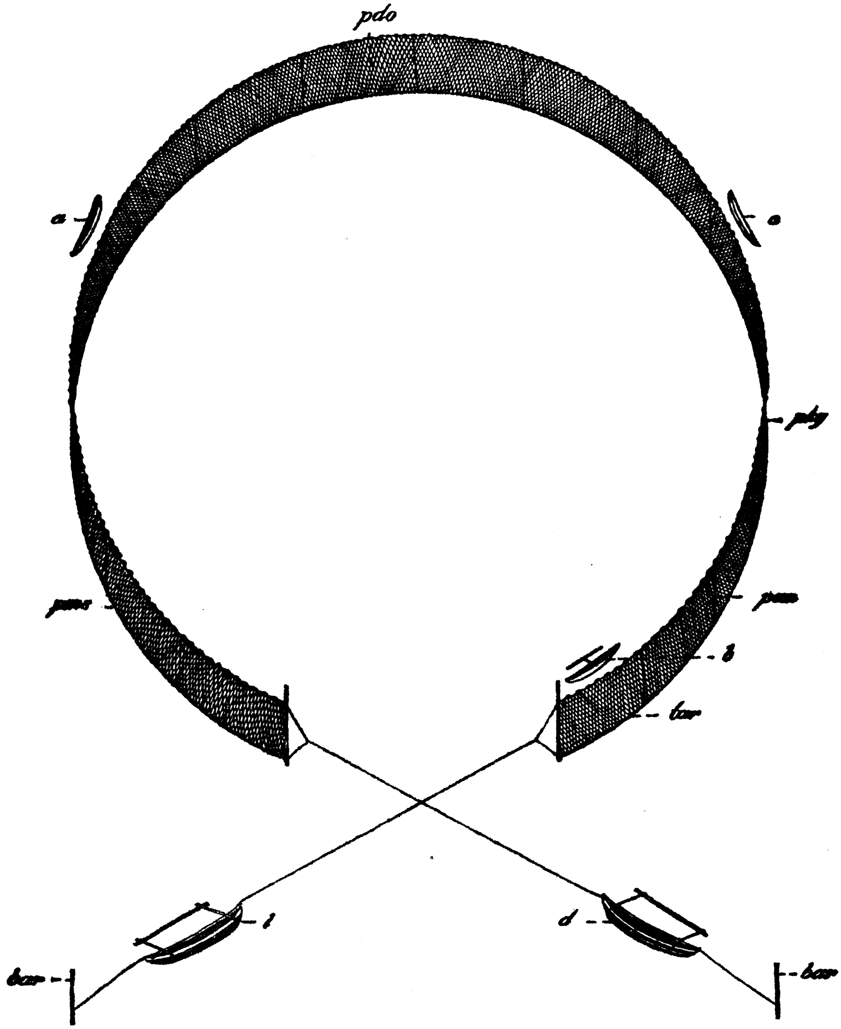

FIG. 1. Initial position of pukot laot.

pamaspas. This operation is continued until the two ends come within about 5 meters of each other.

Meanwhile the men on the alagaan go around the net and inspect the bottom line to see that it is in contact with the bottom of the lake to prevent fish from passing through.

The men on the buralan then drive bamboo poles (*bural*), one very near the free end of the tarupit and another at the joint of the tarupit and panaklob. To these bamboo poles, the *pirmihan* and *parungo*, respectively, are tied the ends of the tarupit. Two other poles, the *alalay*, are placed near the pirmihan, which are used as supports. One of them is placed about 5 meters away, in line with the tarupit, and is moved closer and closer to the pirmihan as the net comes closer to this bural. The other is placed about 5 meters within the enclosure at right angles to the pirmihan and parungo. To these alalay are tied ropes connecting the pirmihan. The free end of the tarupit is ringed to another pole, the *tuhog*, by its rope rings. The tuhog

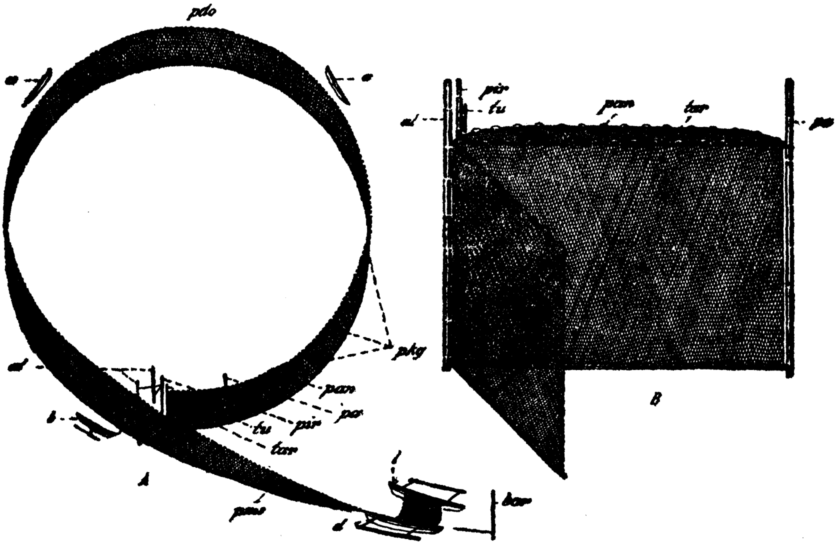

FIG. 2. *A*, Hauling in of pukot laot: *B*, position of the tarupit and panaklob in the final concentration of the fish.

is then tied to the pirmihan. Small ropes (*hugos* or *pamuntot*), about 6 meters long and placed at intervals of about 1 meter, are tied to the bottom line of the tarupit. The hugos is bent into several short loops of about 30 centimeters, bound together by the loose end and buried in mud within the enclosure (Plate 2, fig. 1; text fig. 2, *A*).

While the bural are being placed, the dalagan moves to a new position, coming close to the lambatan. After anchoring, the men continue to pull in the pamaspas by means of the rope and the sinker and float lines are then held together with the netting rolled around them. Pulling is continued with the help of some

men transferred from the lambatan to the dalagan, while the others remain behind to load the pulled portion of the pukot into the lambatan. Pulling and loading of the net is continued, gradually reducing the size of the enclosure. The divers, *magaalaga,* continually inspect the bottom line of the net, especially the moving portion, seeing to it that it is not raised during this operation and that it drags very smoothly on the bottom. The men at the tarupit beat the water and create noise to drive the fish to the farther portion of the enclosure. They also help in the inspection of the bottom line of the net near the pirmihan.

When about two-thirds of the net has been pulled and loaded and the moving portion has come very close to the pirmihan, the dalagan and lambatan transfer to a new position in alignment with the net. This operation, called *paling,* reduces the strain in pulling and avoids damaging and wearing the net by friction against the pirmihan. The alalay in the enclosure of the net is now removed, and pulling and loading of the net is resumed until the panaklob has closed the opening of the dip of the tarupit. The magaalaga then signal the men on the dalagan to stop pulling the net. Then the bottom line of the panaklob is pulled alone until it comes close to that of the tarupit (text fig. 2, *B*).

As soon as this is accomplished, the dalagan is rowed to the tarupit and tied with the outriggerless side toward the pirmihan and parungo and the men start to pull the hugos or pamuntot that have been brought out of the water by the magaalaga, while the men in the lambatan continue to load the pangkulong of the pukot. The sinker line is lifted and the pamuntot is pulled; the tarupit is thereby converted into a bag containing the catch. The panaklob is then detached and the tuhog pulled out of the water. The tarupit is untied from the parungo and pirmihan and the sides together with the nettings near the sinker line are lifted and the catch concentrated. The fish is brailed out by means of a small dip net (*salok*) that also serves as a measure in selling fish to the middlemen.

Pukot laot is the largest of the drag seines used in Laguna de Bay. The word *laot* means that this pukot is operated on the deeper and farther portions of the lake. The bulk of the catch is kanduli (*Arius* spp.) although *biya* [*Glossogobius giurus* (Buchanan-Hamilton)] is also caught in appreciable quantities together with a few other species of fish found in the lake. With the depletion of kanduli, to be discussed later, biya has increased

in proportion in the catch of the pukot. This tendency has been shown also in the baklad. (Villadolid, 1934.)

OTHER KINDS OF PUKOT

Pukot alañgan.—This pukot resembles very closely the pukot laot and is operated in much the same way, but it is shorter and narrower than the latter. This pukot has 19 to 25 banatan (approximately 1,000 to 1,500 meters) with a depth[1] ranging from 5 to 7.5 meters. It is operated in the lake when and where the water is about 3 to 4 meters deep, and the same species of fish taken by the pukot laot are caught.

Pukot barimbao.—The *pukot barimbao* consists of 9 to 18 banatan and is about 500 to 900 meters long, with a depth of 4 to 6 meters. Only one large banca, which serves as dalagan and lambatan, is used, as in the operation of this pukot the net is left in water until after the catch has been brailed out. It is operated in the same manner as the pukot alañgan or the pukot laot. This pukot catches the same species as the other two pukot described above, but more dalag (*Ophicephalus striatus* Bloch) are included.

Pukot dalag.—The *pukot dalag* is the smallest of the drag seines used in Laguna de Bay, and is operated in shallow waters, just beyond the vegetative zone. Aldaba (1931) gives a short description of this pukot. The net is made of 6 to 8 banatan and is about 300 to 500 meters long and 3 to 4.5 meters deep. Only one banca, 8 to 10 meters long, about 1 meter wide, and 1 meter deep, and provided with an outrigger, is used in the operation of this pukot. The operation resembles closely that of the barimbao, except that the tarupit is held high above water with stakes to prevent the dalag from jumping out. This pukot is primarily used to catch dalag but may also take a small number of other species.

THE PUKOT IN RELATION TO THE KANDULI FISHERIES OF LAGUNA DE BAY

THE NUMBER OF PUKOT AND FISHING AREAS IN THE LAKE

The pukot is operated in practically every portion of Laguna de Bay except the marshy, sandy, and stony places, which present obstructions or are too shallow to permit the successful operation of the pukot. Pukot fishermen also find difficulty in places oc-

[1] It is customary to take the width of the pangkulong as the depth of the pukot measured with the meshes of the nettings stretched.

cupied by *baklad* (fish corrals) and *bobó* (bamboo fish traps). They often have trouble with the owners of these traps and run the risk of tearing their nets on submerged poles.

The area of Laguna de Bay is about 93,000 hectares. Deducting from this area about 15,000 [2] hectares of marshy, sandy, and stony places where pukot cannot operate, 77,000 hectares are open for pukot fishing. The total length of 99,948 meters (Table 1) of the 150 pukot nets used in the entire lake will enclose a circular area of 79,482 hectares. This area is greater by 2,412 hectares than the area of the lake available for pukot fishing, and is only a little smaller than the total area of Laguna de Bay.

TABLE 1.—*Kind, number, and length of pukot, by municipalities in Laguna de Bay.*

Municipality.	Pukot laot.		Pukot alañgan.		Pukot barimbao.		Pukot dalag.		Total.	
	Number.	Length.	Number.	Length.	Number.	Length.	Number.	Length.	Number.	Length.
		m.		*m.*		*m.*		*m.*		*m.*
LAGUNA										
Calamba							8	1,824	8	1,824
Los Baños	2	2,940					2	530	4	3,470
Pila	3	5,545					10	2,650	13	8,195
Paete			3	3,780					3	3,780
Pakil			3	3,954					3	3,954
RIZAL										
Tanay	4	6,320			1	982			5	7,302
Morong							48	13,056	48	13,056
Cardona	2	3,008			3	3,032			5	6,040
Binañgonan	5	8,082			7	3,920	1	330	13	12,332
Angono	10	15,005	2	2,212	11	6,500			13	23,717
Tagig					7	4,790	5	1,790	12	6,580
Muntinlupa	1	1,623	3	3,032	9	5,043			13	9,698
Total	27	42,523	11	12,978	38	24,267	74	20,180	150	99,948

Of course, in actual fishing the area available to pukot fishing is not entirely covered by all pukot in a day. Each operates singly and encloses a small portion of the lake. An average-sized pukot of 25 banatan (2,000 meters) in Laguna de Bay will enclose about 18 hectares. One hundred and fifty pukot of this size will fish out 2,700 hectares a day and may cover the entire area available to pukot fishing in about a month. However, not all pukot operate at the same time in any single

[2] The area of these places has been calculated by means of a planimeter.

day, and fishing with small pukot is limited to certain depths of water. Were it not for the fact that fish constantly move, the lake would be exhausted of fish within a month. In any case, it is obvious that one hundred and fifty pukot are too many for a lake as small as Laguna de Bay, and that pukot alone is enough to overfish and deplete the kanduli fisheries of Laguna de Bay even if eggs and immature and spawning fish are given full protection.

EFFECT OF PUKOT FISHING ON SPAWNING KANDULI

The usual pukot fishing season is during the dry months, January to July. During the last few years, however, some pukot operated throughout the year. Observations show that pukot catch most fish during April to June, the period when the water level of Laguna de Bay is at its lowest (text fig. 3), and when kanduli congregate in large schools to spawn (Mane, 1929).

The brooding male kanduli captured eject the eggs they incubate in their mouths, which drop to the bottom of the lake to rot, as they cannot develop further. Heaps of eggs are not infrequently found under the tarupit of the pukot after the catch has been brailed out during the spawning season of the kanduli. Some of these eggs are gathered by fishermen and sold on land. As many as 5 to 10 kerosene cans of eggs are landed by a single pukot in a day. The fingerlings that are able to hatch from the eggs, especially at the end of the spawning season, are also caught by the pukot, as the meshes of the net are too small to allow the passage of small fishes. These are probably the reasons pukot is considered the fishing gear most destructive to the kanduli fisheries of Laguna de Bay.

SIZE COMPOSITION OF KANDULI CAUGHT BY PUKOT

In order to determine the present composition of kanduli caught by pukot, four samples were collected in four different portions of the lake in August. In taking the samples a small dip net was used to brail out the fish from the tarupit. A dipnetful of fish was used as a sample. The fish were measured from the tip of the snout to the end of the caudal vertebræ. Text fig. 4 shows the result.

Text fig. 4 shows that only the first and second-year-size groups are represented, and that the greater proportion, 75.47 per cent, of the fish in the samples collected are immature. The larger-sized kanduli, from 25 to 37 centimeters long, recorded

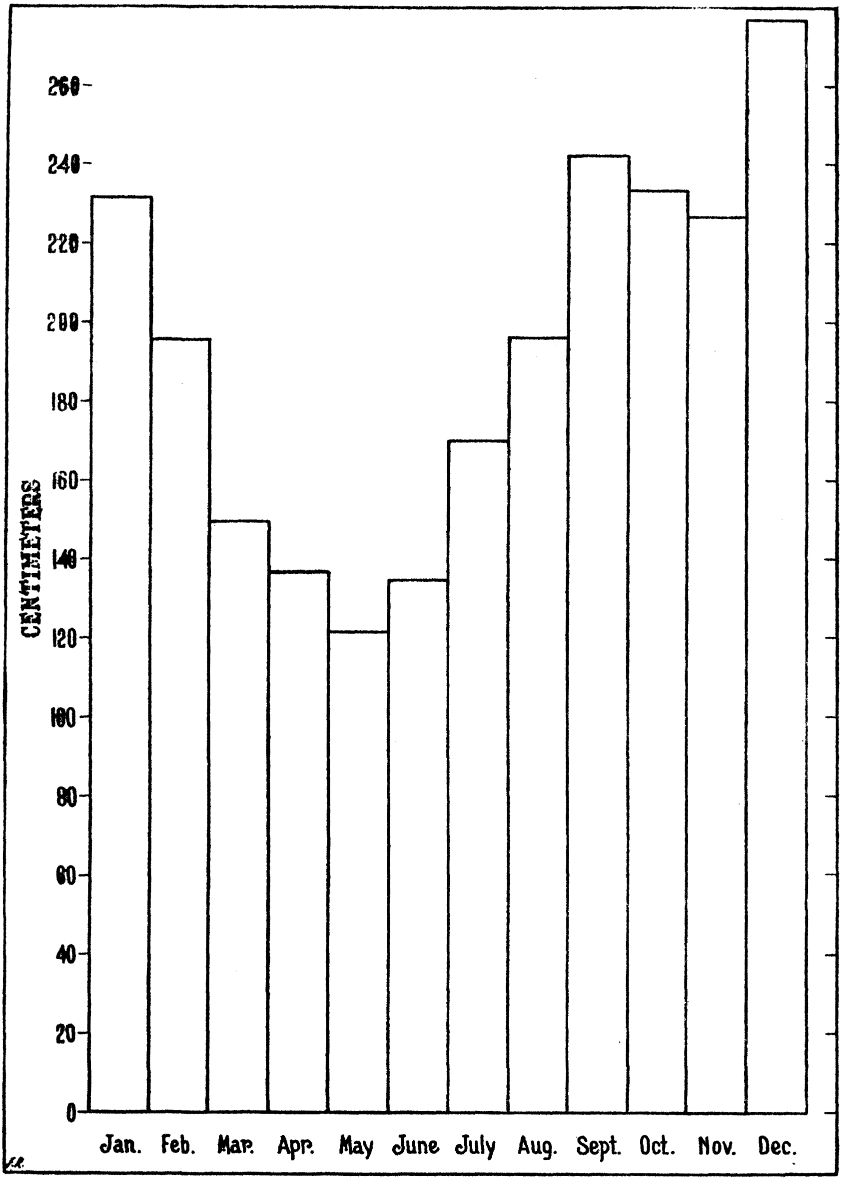

FIG. 3. Monthly average of the water level of Laguna de Bay from June, 1935 to August, 1938. (Data taken partly from the record of the gauge keeper of the Bureau of Public Works at Los Baños, Laguna, and partly from Cendaña and Mane, 1929.)

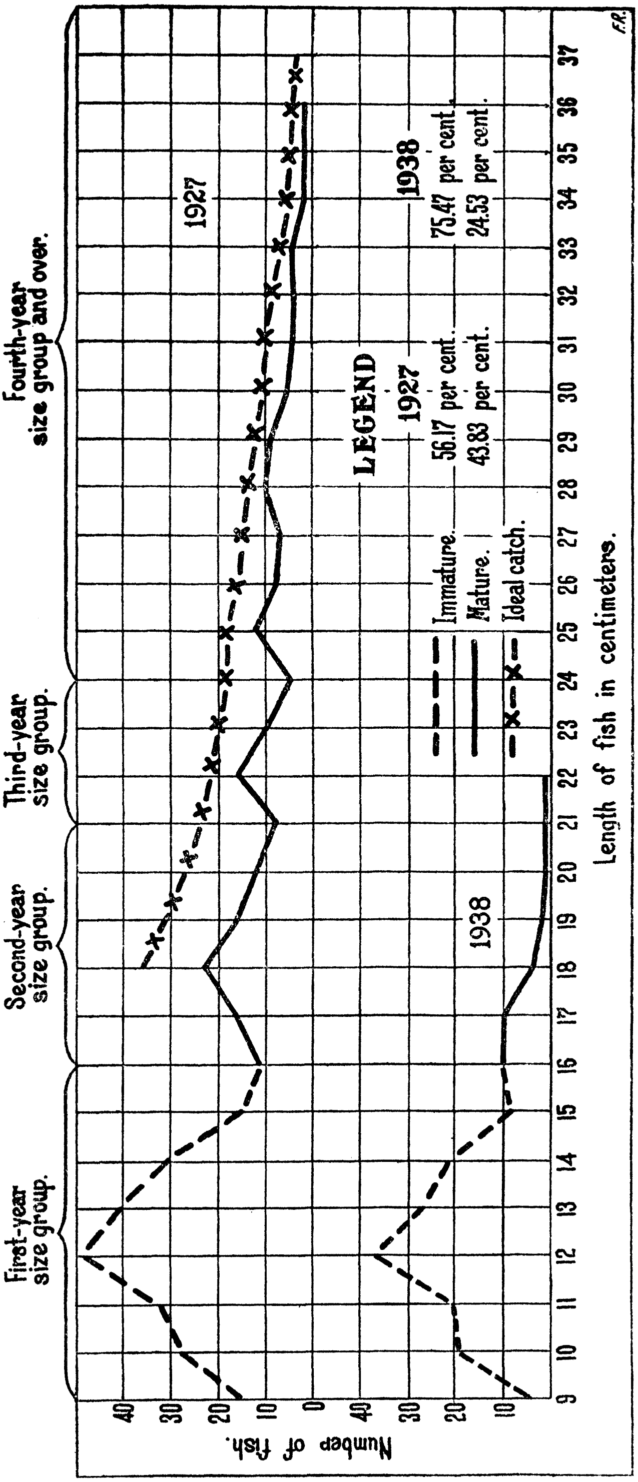

FIG. 4. Average length frequency of kanduli caught by pukot, from samples taken in September, 1927, and August, 1938.

in 1927 (Mane, 1929), were absent in the present catch of pukot. Moreover, the fish in the second-year-size group are very few and fail to form a distinct mode, indicating that the quantity in the lake is very small. This group is now the only source of the first-year-size group, showing clearly that depletion of kanduli in Laguna de Bay is very acute and that it has reached a point when the fish can hardly reach maturity.

The scarcity of kanduli in Laguna de Bay is further evidenced by the fact that the present catch of pukot is relatively very small. Observations made about ten years ago showed that an average catch of pukot laot was from 50 to 100 *kaengs* [3] in a single operation. On this trip no pukot was seen to catch more than 10 kaengs of kanduli.

An effective program of conservation and rigid enforcement of regulations is needed to conserve and rehabilitate the kanduli fishery in Laguna de Bay. By such regulations the aim should be to reach the level of abundance of the fish in the lake, so that an ideal economic catch would consist of mature fish with practically all the mature-size groups represented, as indicated by a theoretical smooth curve in text fig. 4. This ideal catch could be attained more or less by properly protecting the immature fish and breeders and providing fish refuges.

REGULATIONS ON THE USE OF THE PUKOT

The existing regulations on the use of pukot are embodied in the Fish and Game Administrative Order No. 3, which reads as follows:

> It shall be unlawful during the closed season period for any person, association or corporation to use "seket" and "pukot", "pukot laot" or "pukot alañgan" in Laguna de Bay from April 16 to July 15 of each year.

The closed season is directed toward the conservation of the kanduli by protecting the spawning fish and eggs. It has been shown that the kanduli can easily be depleted by pukot even if the eggs and immature and spawning fish are given full protection, and that a large proportion of the pukot catch consists of immature fish. It is, therefore, evident that the present regulations restricting the uses of pukot are still inadequate for the conservation of kanduli in Laguna de Bay, and it is suggested that Fish and Game Administrative Order No. 3 be amended by providing reserved areas that should not be entered by the

[3] Bamboo basket of about 30 kilograms capacity.

pukot and other gear, standardizing the mesh of the tarupit to allow the passage of immature fish, and limiting the length and depth of the pukot. By this limitation the deeper portions of the lake would also serve as partial refuges. Text fig. 5 shows the contour of the different depths of water in Laguna de Bay during the annual low lake level; contour lines are based on soundings taken at intervals of 2 feet or 60 centimeters. The area of each depth is calculated on the map by means of a planimeter, and given in Table 2.

TABLE 2.—*Area of different depths of Laguna de Bay at annual low lake level.*

Minimum depth.	Area contained in each elevation.	Cumulative total.
Ft.	*Ha.*	*Ha.*
17	235	235
15–17	4,660	4.895
13–15	13,551	18.446
11–13	16,836	35,282
9–11	19,628	54.910
7–9	5,978	60.888
0–7	32.182	93,070
Total area of the lake	93,070	93,070

If the width or depth of the pukot is limited to 5.5 meters or about 18 feet (measurement of the pangkulong with meshes stretched) it will actually have a depth of 4.7 meters or about 15 feet, due to the widening of the meshes. This depth will be further reduced by 1 foot because of the current and pulling forces, so that in actual operation the net would be 4.4 meters or 14 feet wide or deep. This depth of the net cannot be operated in water deeper than 15 feet; thus the area of the lake that will ultimately be untouched by the pukot will be about 5,000 hectares, during the minimum water level of the lake in May. This area will be increased with the rise of the water level of the lake during the rainy season. The maximum height of water of Laguna de Bay from June, 1935, to August, 1938, was 3.10 meters above sea level, and the average minimum level was 1.21 meters, or a difference of 1.89 meters (about 6 feet). A rise of 60 centimeters (2 feet) will reserve areas deeper than 13 feet, or 18,446 hectares; of 120 centimeters (4 feet), areas beyond 11 feet deep or 35,282 hectares; of 180 centimeters (6 feet), areas deeper than 9 feet or 54,910 hectares (text fig. 5).

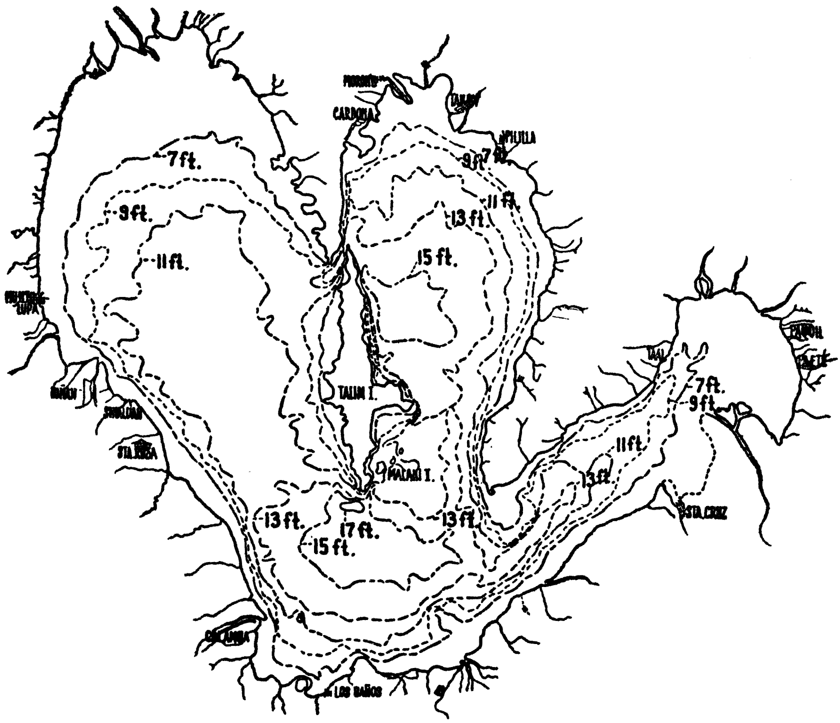

FIG. 5. Map of Laguna de Bay showing the countour of depths of water at 2 feet (about 60 centimeters) intervals at annual low lake level.

The number of pukot in Laguna de Bay is classified according to depth of the pangkulong as follows:

Depth of pangkulong.	Number of pukot.
m.	
4.0	92
4.5	13
5.0	2
5.5	9
6.0	12
6.5	2
7.0	0
7.5	3
8.0	19
Total	150

Thirty-six pukot will be affected when the maximum depth of 5.5 meters is applied. These, mostly the pukot laot and pukot alañgan, may continue to fish, however, if reduced in depth.

The netting commonly used for the tarupit is No. 6. When the net is new, the meshes stretched measure 3.5 centimeters. However, after several treatments with tanning extract and cow's blood, the meshes decrease in size by about 0.5 centimeter. This size does not allow immature fishes to pass through. It is recommended that nettings of not less than 4 centimeters mesh stretched after treatment be used for the tarupit. It was found that a dip net with this size of meshes used to brail the catch allows a great proportion of young kanduli to pass through. The few immature fish that remain are from 14 to 16 centimeters long, almost the size attained by kanduli at sexual maturity.

SUMMARY

1. The present paper is a report on the pukot fisheries of Laguna de Bay, dealing with the description and operation of pukot; pukot in relation to kanduli fisheries; and regulations on pukot.

2. Pukot is the most important and most effective fishing gear in Laguna de Bay. There are 150 of these nets, valued at about 95,000 pesos, with about 3,000 fishermen directly engaged in their operation. There are about 1,000 middlemen who buy the catch of pukot to be sold on land.

3. The description and operation of *pukot laot* are given. Four kinds of pukot are used in Laguna de Bay; namely, pukot laot, pukot alañgan, pukot barimbao, and pukot dalag.

4. The depletion of the fisheries of Laguna de Bay is aggravated by overfishing, with pukot too numerous for such a small lake. These nets, if joined end to end, will enclose an area little smaller than that of the lake and more than that available for pukot fishing. An average-sized pukot will enclose 18 hectares, and the 150 pukot can fish out 2,700 hectares of the lake in a day, operating singly. The total area available to pukot fishing can be covered by the 150 pukot in about a month.

5. An enormous quantity of fish eggs are destroyed, and immature fish are caught in great quantities with the fine-meshed nets, because the fishing season for pukot coincides with the spawning season of kanduli.

6. The depletion of kanduli in Laguna de Bay is very acute. The point has been reached when fish hardly reach maturity.

7. The provisions of Fish and Game Administrative Order No. 3 are not adequate for the conservation and rehabilitation

of the kanduli fisheries of Laguna de Bay. It is suggested that certain areas be reserved and the mesh openings of the tarupit of pukot standardized.

It is recommended that section 3(b) of the Fish and Game Administrative Order No. 3 be amended to read as follows:

(*b*) It shall be unlawful for any person, association, or corporation:

(1) To use any kind of pukot of more than 1,800 meters (30 banatan of 3,000 meshes, of 60 meters each) and pangkulong more than 5.5 meters deep (with mesh stretched) and tarupit with mesh stretched less than 4 centimeters.

(2) To fish with any kind of pukot longer than 500 meters (8 banatan of 3,000 meshes each) and with pangkulong 4.5 meters deep and tarupit with meshes stretched less than 4 centimeters, during the close season period from April 16 to July 15, inclusive, of each year.

(3) To fish with any kind of pukot, seket, and other fishing gear in any area reserved or that may later be reserved as fishery refuge and sanctuary in Laguna de Bay.

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ILLUSTRATIONS

PLATE 1

PLATE 2

TEXT FIGURES

[Abbreviations: *a*, Alagaan; *b*, buralan or pangipitan; *d*, dalagan; *l*, lambatan; *ta*, tarupit; *pan*, panaklob; *pkg*, pangkulong; *pdo*, panglundo; *pms*, pamaspas; *bar*, barahan or pamondo; *al*, alalay; *pir*, pirmihan; *tu*, tuhog; *pa*, parungo.]

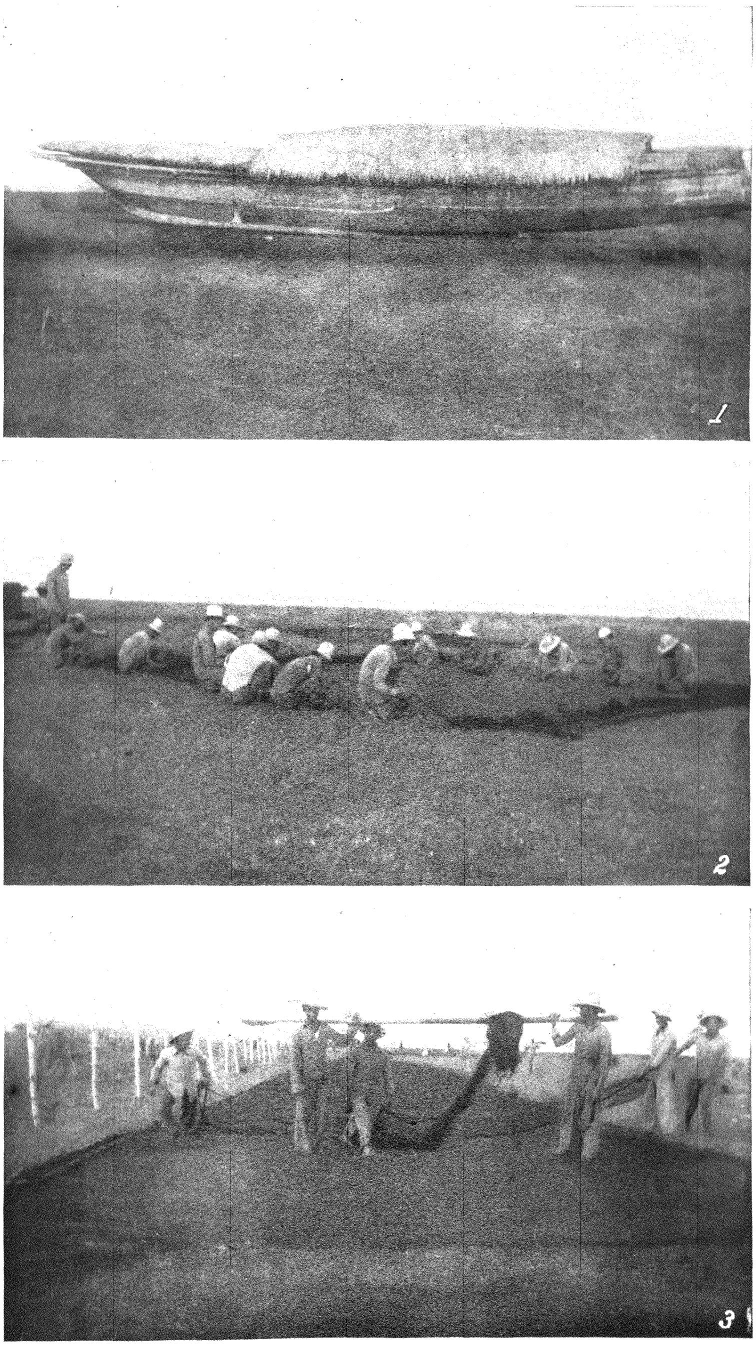
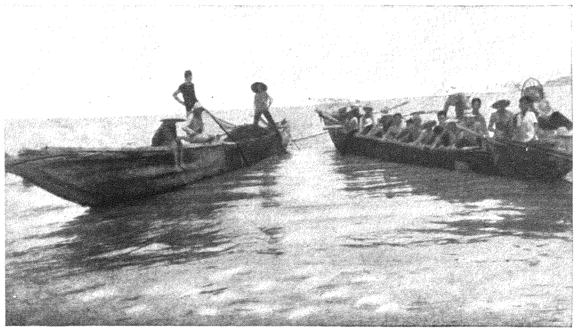


PLATE 1.



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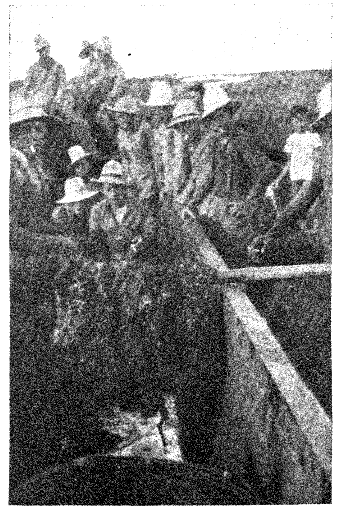

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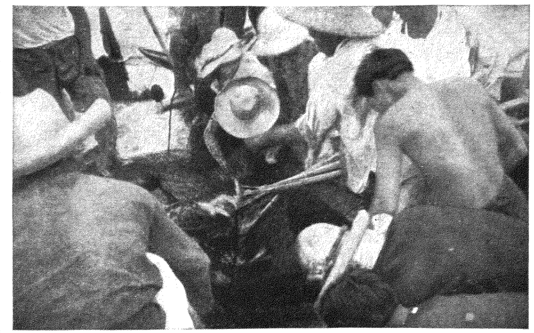

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PLATE 2.

XENOJULIS, A NEW GENUS OF LABROID FISHES

By L. F. de Beaufort

Of Amsterdam, Holland

THREE TEXT FIGURES

Among the collection of labroid fishes from the Philippines kindly sent me for identification by the Bureau of Science, I find two specimens belonging to different species, but both members of the same genus, hitherto undescribed. The description of the new genus is given below, as well as the description of a new species under this genus.

Genus XENOJULIS novum

Oblong, compressed. Body covered with large scales, scales on thorax and before origin of dorsal not smaller than others. Head naked. Preopercle smooth. Jaws with single crowded row of rather robust, pointed teeth, increasing in size anteriorly, where they are canines; foremost pair of teeth in lower jaw fitting into space between foremost pair in upper jaw, which are stronger than the others and a little apart, to receive the lower pair. Upper jaw with posterior canine. Lower pharyngeals concave behind; about three irregular rows of small conical teeth on body, two rows of similar teeth on anterior expansion of bone. Posterior row on body of bone consisting of somewhat larger teeth, median tooth of this row much larger than others. Mouth small, scarcely protractile. Dorsal with 9 spines and 11 soft rays. Anal with 3 spines and 11 soft rays. Dorsal and anal without scaly sheath. Pectorals truncate or somewhat rounded. Ventrals pointed. Caudal rounded. Gill opening rather large. Lateral line continuous, with a sharp bend below soft dorsal. Tubes of perforated scales ramified.

Key to the species of Xenojulis.

1. Caudal with a black spot on middle of upper and lower rays. A black spot between posterior anal rays.................................... *X. margaritaceus.*
2. Dorsal and anal without these markings but with rows of light spots. *X. montillai.*

XENOJULIS MARGARITACEUS (Macleay.). Text figs. 1 and 2.

Platyglossus margaritaceus Macleay, Proc. Linn. Soc. New S. Wales 8 (1883) 27 (nec C. V.).

Halichœres macleayi JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 1906 (1905) 303.

Halichœres macleayi FOWLER, Mem. B. P. Bishop Mus. 10 (1928) 342.

Dorsal, IX, 11; anal III, 11; pectoral 2, 11; ventral I, 5; lateral line, 28 or 29; 2 scales above, 7 to 8 scales below lateral line. Head subequal to height, 2.8 to 3.1 in length, 3.6 to 3.7 in length with caudal. Eye 5 in head, 1.5 in snout, about equal to convex interorbital space. Mouth small, corner before vertical through anterior nostril. Dorsal spines gradually increasing in size posteriorly, last one somewhat more than snout. Membranes between spines incised, four anterior spines sometimes with a short prolongation. Soft dorsal slightly higher than spinous part. Soft anal similar to soft dorsal, both fins rounded behind. Color of preserved specimens yellowish, darker on top of head.

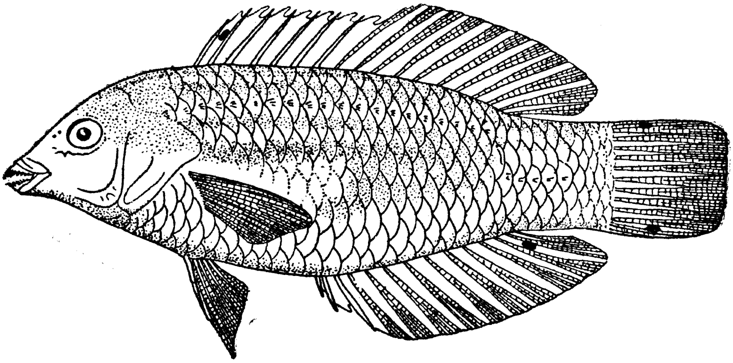

FIG. 1. *Xenojulis margaritaceus* (Macl.), type of *Platyglossus margaritaceus* Macl. After a sketch made by Mr. Gilbert Whitley. Natural size.

A more or less distinct, large, pearly area on middle of sides, more or less edged with black. Body with indications of broad transverse bands (male?) or with traces of dark longitudinal bands (female?). Traces of a pearly marking on operculum. Fins yellowish. A small black blotch between first and second dorsal spines, between ninth and tenth anal rays, and on middle of upper and lower caudal rays. Similar blotches may also be present (in male?) between second and third and between third and fourth dorsal spines, between first and second and between fifth and sixth anal, and a larger one between seventh and ninth dorsal rays. Two small spots may also be present (in the male?) on the ventral fin, one between first and second and one between second and third rays.

Two specimens known, one 95 mm long, from Hood Bay, New Guinea (*Platyglossus margaritaceus* Macleay) and one 74 mm

long, from Barrio Nalvo, Luna, La Union Province, Luzon, August 10, 1926, Bur. Sci. 14283, *Jose Montilla.*

This species was first described by Macleay. In this short description the number of dorsal spines is given as seven, and as I had a suspicion that my specimen from the Philippines might be of the same species as that of Macleay, I asked Mr. Gilbert Whitley to give me some information about the type specimen of Macleay. Mr. Whitley kindly gave me all the information I wanted, after he had got permission from Mr. N. Salter, curator of the Macleay Museum, Sydney, to examine the type. I thank these two gentlemen for their help in solving the identity of this remarkable species. Although the type has seven spines in the dorsal, as described by Macleay, I presume that this is an abnormality. Specimens of labroid species that have less than the normal number of spines have been

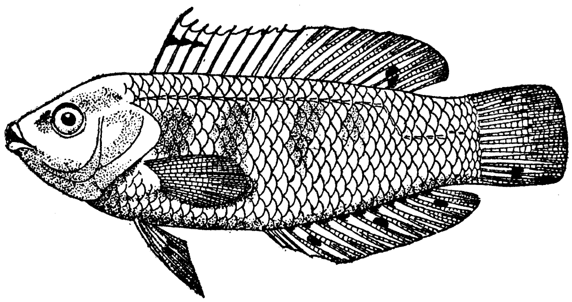

FIG. 2. *Xenojulis margaritaceus* (Macl.), Bur. Sci. 14283. Natural size.

recorded more than once. The specimen from Hood Bay and that from the Philippines are so much alike that it seems impossible that they belong to different species or different genera. Mr. Whitley kindly made a sketch of the type, which I reproduce here with a figure of the specimen from the Philippines. In this last specimen, a little smaller than the type, the number of blotches on the fins is greater than in the type, the first dorsal spines are somewhat produced, and there are traces of transverse bands on the body. This specimen may be a male and that from Hood Bay a female.

Before discussing the genus I will first describe a second species, which I propose to call *montillai,* in honor of the collector.

XENOJULIS MONTILLAI sp. nov. Text fig 3.

Dorsal IX, 11; anal III, 11; pectoral 2, 11; ventral I, 5; lateral line, 29; 2 scales above, 9 scales below lateral line. Height 2.9, in length, 3.5 with caudal. Head 3.2, in length, 3.9

with caudal. Height of head about 1.1 in its length. Eye 4.6, 1.6 in snout and 1.2 in convex interorbital space. Mouth small, corner before vertical through anterior nostril. Dorsal spines long and slender. Third spine longer than others, which are subequal in length; third spine about equal to snout and eye together. Soft dorsal higher than spinous part, pointed behind. Third anal spine longest, about as long as first dorsal spine. Pectorals as long as postorbital part of head. Ventrals pointed, first ray produced, longer than pectorals. Caudal rounded. Color of preserved specimen yellowish, upper part of head darker. Body with an indication of a longitudinal darker band and with traces of darker transverse blotches. Spinous dorsal white, with deep black blotches between first and second, second and third, third and fourth, and fourth and fifth spines. Soft

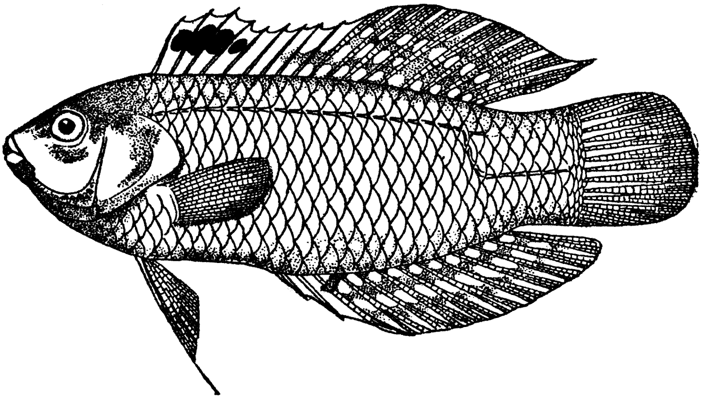

FIG. 8. *Xenojulis montillai* sp. nov. Natural size.

dorsal light brownish, with three irregular rows of white spots. Soft anal with similar rows of spots. Caudal white, upper and lower rays dusky.

A single specimen, 90 mm long, from Barrio Paraoir, Balawan, La Union Province, Luzon, December 16, 1925. Bur. Sci. 13050, *Jose Montilla.*

This species is very close to *X. margaritaceus,* from which it differs by its coloration and markings and by the different shape of the dorsal.

Xenojulis is related to *Halichœres* and to *Stethojulis,* perhaps more to the latter than to the former. It differs from *Halichœres* in having the scales of the thorax and those before the dorsal not smaller than those of the sides. In this respect it agrees with *Stethojulis,* where the thoracic scales generally are

even larger than those of the sides. *Xenojulis* differs, however, from *Stethojulis* in its dentition. The teeth in the jaws are pointed, not more or less incisiviform as in *Stethojulis,* and the anterior teeth are much larger than the posterior teeth, forming well-developed canines. In this respect *Xenojulis* again agrees with *Halichœres,* in which, however, the teeth are not so crowded as a rule. The lower pharyngeals, concave behind, are more like those of *Stethojulis* than those of *Halichœres,* but the difference is very slight and of no great importance.

As it is not quite sure that my specimen from the Philippines and that from New Guinea belong to the same species, although I have little doubt that the number of dorsal spines is abnormal in the latter specimen, I think it safer to select not the first described species but *Xenojulis montillai* as the type of the genus.

ILLUSTRATIONS

TEXT FIGURES

NOTES ON SOME PHILIPPINE XYLOCOPA (HYMENOPTERA: XYLOCOPIDÆ)

By TSING-CHAO MAA

Of Daw-Tsuen, Hangchow, China

The present paper is a report concerning *Xylocopa* material sent me for study and determination by Dr. A. Roman, of the Entomologiska Advelningen, Naturhistoriska Riksmuseum in Stockholm, and by Dr. W. Horn, Director of the Deutsches Entomologisches Institut, Berlin-Dahlem. In addition to records and taxonomical notes of previously described species and subspecies, the description of a new species and a check list of the known species of Philippine *Xylocopa* are also offered.

I am greatly indebted to Doctors Roman and Horn for loan of the material.

Genus XYLOCOPA Latreille (1802)

Subgenus BILUNA Maa (1938)

XYLOCOPA NASALIS MCGREGORI (Ckll.).

The present subspecies is scarcely separable from *X. nasalis iridipennis* (Lepel.) except in the following characters:

X. n. mcgregori Ckll.	*X. n. iridipennis* Lepel.
Genæ punctate.	Genæ impunctate.
Breadth of impunctate disc of mesonotum about one-fifth interspace between tegulæ.	Breadth of impunctate disc of mesonotum about one-third interspace between tegulæ.
Punctuation on median portion of abdominal tergite II relatively coarser, mostly in second-degree density.[1]	Punctuation on median portion of abdominal tergite II relatively finer, mostly in third-degree density.

The knee caps on the posterior tibiæ of *mcgregori* Ckll. are usually V-shaped, while those of *iridipennis* Lepel. are sometimes apically blunt or truncate. In some females of *iridipennis* Lepel. from the Sunda Island the outer orbital margins are grooved, but not in *mcgregori* Ckll.

Specimens examined.—"Philippine Is.," 1 female, Stockholm Museum; 3 females, author's collection.

[1] Terminology of Allen et Jaynes, Proc. U. S. Nat. Mus. (17) 76 (1930) 4.

Subgenus ORBITELLA Maa (1938)

XYLOCOPA PHILIPPINENSIS F. Sm.

Genæ impunctate, minimum length about thrice diameter of mandibular punctures. Upper portion of outer orbital margins with a deep narrow groove. Postgenæ and vertex strongly punctate in second-degree density. Coronal suture irrecognizable, represented by a narrow median impunctate band of vertex. Wing vein M longer than M_{1+2} (1st section); vein r-m S-curved, vein R_4 angulate at a point of basal two-thirds of its length. Posterior trochanters apically flattened and narrowly rounded. Inner teeth of anterior and posterior claws, respectively, about one-half and one-third as long as the corresponding outer teeth.

Specimens examined.—Mont Albon, one female, W. Schulthess, Deutsches Entomologisches Institut. (det. Maidl).

XYLOCOPA CHLORINA (Ckll.).

Female.—Originally described as a variety of *X. philippinensis,* from which it may be distinguished by the following characters: Wings basally with greenish coppery golden lustre, apically with rosy purplish tints. Occiput with few scattered yellow hairs. Scutellum entirely yellow-haired, with very scattered black hairs on median area of anterior portion. Frontal keel not broadened at its midway. Coronal suture basally distinct. Wing vein M subequal in length to M_{1+2} (1st section). Punctures on median portion of abdominal tergites III and IV comparatively sparser, with a more or less distinct median impunctate band.

Specimen examined.—Los Baños, one female, Baker, Deutsches Entomologisches Institut.

XYLOCOPA NEGLIGENDA sp. nov.

Male unknown.

Female.—Closely allied to *X. philippinensis* F. Sm.

Wings with faint rosy purplish lustre, apically with a slight greenish tint. Posterior half of scutellum yellow-haired. Postscutellum and thoracic pleurites entirely yellow-haired. Tegulæ black-haired. Extreme basal portion of wings and dorsal surface of anterior tibiæ covered with dominant yellow and scattered black hairs. Relative interorbital distance at the level of antennal fossæ to vertico-clypeal distance about 11: 14. Median fovea of frontal keel deep and broad. Epistomal suture moderately ridged. Width of median impunctate band of clypeus

about thrice diameter of clypeal punctures. Genæ twice as long as diameter of mandibular punctures. Postgenæ with very scattered coarse punctures of third-degree density, upper portion scarcely punctate. Vertex medially coarsely punctate in first-degree density, without median impunctate band, laterally (also interspaces between lateral ocelli and inner orbits) unevenly punctate in second-degree density. Length of interocellar distance to that of ocello-ocular distance about 9:17. Length of antennal segment III to that of segments IV to VI as 8:9. Segment IV longer than broad. Wing vein M about one and one-fourth as long as M_{1+2} (1st section).

Body, 30 millimeters; anterior wing, 24.

Holotype.—Tayanito Mai, one female, deposited in the Stockholm Museum.

In the distribution of the pubescence and in the density of the postgenal punctuation this new species is quite distinct from any member of the *X. philippinensis* group.[2] Superficially the present species and *X. ghilianii* Grib. are alike, but their wing color and breadth of thoracic collar are different.

XYLOCOPA GHILIANII Grib.

Female.—Redescribed here as follows:

Black, antennal segments IV to XII dark testaceous below. Wings fuscous, darkest at the cell $Sc + R_1 + R_2$, with beautiful greenish golden iridescence, basally with a slight bluish tint. Pubescence black, but on face, postgenæ, and dorsal surface of anterior tibiæ mixed with very few whitish hairs; pronotum, marginal areas of mesonotum, scutellum, thoracic pleurites, and extreme basal portion of wings with bright yellow hairs; post-scutellum and anterior half of abdominal tergite I with dominant yellow and a few scattered black hairs; apex of abdomen with slightly ferruginous hairs. Length of interorbital distance at level of antennal fossæ to vertico-clypeal distance 9:11. Inner orbits very weakly curved, distance between upper orbital extremities distinctly greater than that between lower. Face strongly punctate in first-degree density. Frontal keel weak, rather broad, roundly ended, its median fovea long, narrow. Supraclypeal region medially impunctate. Epistomal suture very weakly curved, not at all ridged. Clypeal sutures strongly curved. Tentorial pits small, oblong. Clypeus medially impunc-

[2] Cockerell (1930).

tate and moderately carinate. Labrum strongly tuberculate, with broad, shallow apical emargination. Genæ impunctate, minimum length about thrice diameter of mandibular punctures. Outer orbital margin with a deep and rather broad groove. Postgenæ with strong punctures of second-degree density, those on upper portion much sparser. Vertex strongly punctate in first-degree density, median band impunctate. Coronal suture irrecognizable. Interocellar distance to ocello-ocular distance 9: 16. Basal side of ocellar triangle about 2.5 times that of either lateral side. Postocellar pits round, shallow. Interantennal distance about $\frac{6}{7}$ that of antenno-ocular distance. Antennal segment III about three-fourths as long as segments IV to VI; segments IV and V subequal. Dorsum of thorax strongly punctate in first-degree density, except disc of mesonotum and median band of scutellum which are impunctate; scutellar punctuation a little finer than mesonotal. Wing vein M about one and one-third as long as M_{1+2} (1st section); vein R_4 weakly curved at a point of basal two-thirds of its length. Knee caps on posterior tibiæ V-shaped, extending to basal three-sevenths of tibial length; apical two-thirds of upper margin distinct. Abdominal tergites strongly and evenly punctate in first-degree density, without distinct median impunctate band; median furrow of epipygium narrow. Posterior margin of abdominal sternites with weak median extension; hypopygium medially keeled.

In the female received from the Stockholm Museum the thick yellow pubescence posteriorly extends to the posterior margin of abdominal tergite I, but anteriorly not beyond the anterior margin of the scutellum. In the female from Camiguin the wings are rosy purple, and apically with a greenish golden tint; the head is without pale hairs; the lateral surfaces of the thorax are black-haired posteriorly; the extreme basal portion of the wings is black-haired; the supraclypeal region is evenly punctate; the coronal suture is recognizable at its extreme base and the vertex is without a median impunctate band.

Female, length of body, 23 to 24 millimeters; anterior wing, 22 to 23.

Specimens examined.—Camiguin Island, one female, July 16, Böttcher, Deutsches Entomologisches Institut (det. Schulthess); "Philippine," one female, Stockholm Museum.

XYLOCOPA CANARIA (Ckll. et LeVeq.).

Female.—Apparently a slight variation of *X. blüthgeni* Dusm., which is allied to the preceding species. Wings a beautiful

green, with a slightly golden tint, basally with a slight purplish luster. Posterolateral portions of mesonotum, base of tegulæ, and extreme basal portion of wings all yellow-haired. Dorsal surface of anterior tibiæ with a very narrow band of yellow hairs. Posterior half of abdominal tergite I black-haired. Epistomal suture weakly ridged. Mandibles similar to those of *X. cuernosensis* (Ckll.). Minimum length of genæ about twice diameter of mandibular punctures. Vertex punctate in second-degree density. Interocellar distance to ocello-ocular distance 9 : 13. Antennal segment III about seven-eighths as long as segments IV to VI; segment IV broader than long, distinctly shorter than V. Wing veins M and M_{1+2} (1st section) subequal in length. Knee caps on posterior tibiæ extending to basal half of tibial length. Punctures on median portion of abdominal tergites in second-degree density, interspaces between proximate rows of punctures mostly shorter than punctual diameter.

Specimens examined.—Ipil, Talibon, one female, Stockholm Museum.

XYLOCOPA BLÜTHGENI Dusm.

Female.—Differing from *X. ghilianii* Grib., as described above, in the following characters: Wings with a little more violaceous luster. Front covered with an intermixture of yellowish and black hairs. Occiput with dominant black and very scattered bright yellow hairs. Black-haired patch in the center of mesonotum less extensive. Postscutellum purely yellow-haired. Dorsal surface of anterior tibiæ with a narrow yellow band. Abdominal tergite I extensively covered with yellow hairs, with very short black hairs present only along extreme posterior margin. Median fovea of frontal keel interrupted. Epistomal suture very weakly ridged. Genæ slightly shorter. Coronal suture recognizable at its extreme base. Antennal segment III about five-sixths as long as segments IV to VI; segment IV shorter than broad, distinctly shorter than V. Median impunctate band of scutellum narrow. Wing vein M longer than M_{1+2} (1st section).

Female, body, 19 to 21 millimeters long; anterior wing, 20.

Specimens examined.—"Philippine," one female, Stockholm Museum.

Many of the Philippine "species" belonging to the genus *Xylocopa* Latr. are known from one sex, usually the female, and on many occasions they are known solely from the type locality. The validity of many names, especially those of the *philippinensis*

and *ghilianii* groups, can be justified only by extensive collection in various localities. Probably some of the names will be treated as synonyms, slight individual variations, or geographical races.

XYLOCOPA CUERNOSENSIS (Ckll.).

Female.—The following notes may be added to the original description given by Cockerell: Wings darkest at cell Sc $+ R_1 + R_2$ and cell R, basally with rosy purple luster. Lower portion of postgenæ ("cheeks" of Cockerell) covered with a mixture of reddish and black hairs. Postscutellum medially black-haired, laterally with dominant ferruginous and a few black hairs. Extreme basal portion of wings with little ferruginous hairs. Apex of abdomen ferruginous-haired. Interorbital distance at level of antennal fossæ about four-fifths verticoclypeal distance. Inner orbits moderately curved, distance between upper orbital extremities distinctly longer than between lower. Face coarsely and evenly punctate in first-degree density. Frontal keel ("ridge between antennæ" of Cockerell) weak, broad, extending to level of antennal fossæ. Supraclypeal region sparsely punctate, without median impunctate band. Epistomal suture ridged. Clypeal sutures strongly curved. Tentorial pits shallow, elongate. Basal portion of clypeus distinctly more elevated than its neighboring lateral frontal regions. Mandibles smooth, basal triangular area coarsely punctate, not depressed, and without distinct demarcation from median keel or outer marginal suture. Genæ impunctate, minimum length about 4 times diameter of mandibular punctures. Upper portion of outer orbital margins with a very deep and rather broad groove. Postgenæ coarsely and very scatteredly punctate in second-degree density, upper portion scarcely punctate. Vertex coarsely punctate in first-degree density. Coronal suture represented by median impunctate band on vertex. Interocellar distance about five-eighths ocello-ocular distance. Basal side of ocellar triangle about two and one-half times either one of the lateral sides. Interspaces between lateral ocelli and inner orbits a little more sparsely punctate. Interantennal distance and antenno-ocular distance subequal. Antennal segment III longer than segments IV to VI; segments V and VI subequal. Dorsum of thorax evenly punctate in first-degree density, except disc of mesonotum and median band of scutellum, which are impunctate. Wing vein M slightly longer than M_{1+2} (1st section); vein r-m ("first t. c." of Cockerell) complete; vein R_4 angulate at a point of basal two-thirds

of its length. Knee caps on posterior tibiæ ("scalelike process on hind tibiæ" of Cockerell) extending to basal half of tibial length. Inner teeth of anterior and posterior claws about three-fifths and one-half, respectively, as long as corresponding outer teeth. Abdominal tergites I to IV medially rather sparsely punctate in second-degree density, laterally in first-degree density; tergite I bipunctate; median furrow of epipygium narrow. Posterior portion of hypopygium weakly keeled.

The specimen before me differs from Cockerell's original description in three respects: lower part of postgenæ not with only long black hair, antennal segment III not a trifle longer than next three segments together, and wing vein r-m complete.

Specimens examined.—Ipil, Talibon, one female, Stockholm Museum.

XYLOCOPA BOMBIFORMIS F. Sm.

Female.—Here redescribed as follows:

Black, antennal segments IV to XII testaceous below. Wings fuscous, darkest at cell Sc $+$ R_1 $+$ R_2 with beautiful purple luster, apically with bluish-green iridescence. Pubescence entirely black. Interorbital distance at level of antennal fossæ to verticoclypeal distance 10: 13. Inner orbits very weakly curved, distance between upper orbital extremities a little greater than that between lower. Face strongly punctate in first-degree density, except interspaces between lateral ocelli and inner orbits, where it is punctate in third-degree density. Frontal keel comparatively strong, roundly ended, with a weak median fovea. Supraclypeal region medially impunctate. Epistomal suture almost straight, very weakly ridged. Clypeal suture strongly curved. Tentorial pits small. Clypeus laterally slightly more elevated than its neighboring lateral frontal regions; median impunctate band narrow, weakly carinate. Labrum tuberculate; apical emargination broad, shallow. Genæ impunctate, minimum length about twice diameter of mandibular punctures. Outer orbital margins with a deep groove. Postgenæ very scatteredly punctate in third-degree density. Vertex evenly and strongly punctate in first-degree density, without median impunctate band, region posterior to upper orbital extremities scatteredly punctate in second-degree density. Coronal suture irrecognizable. Interocellar distance about one-half ocello-ocular distance. Basal side of ocellar triangle about thrice either lateral side. Postocellar pits shallow, round. Length of interan-

tennal distance to antenno-ocular distance 13:16. Antennal segment III about nine-tenths of segments IV to VI; segments V and VI subequal. Dorsum of thorax strongly punctate in first-degree density, except disc of mesonotum and median band of scutellum, which are impunctate. Wing vein M about one and two-fifths as long as M_{1+2} (1st section); vein R_4 weakly angulate at a point of basal two-thirds of its length. Knee caps on posterior tibiæ small, V-shaped, extending to basal half of tibial length. Inner teeth of anterior and posterior claws about three-fifths and one half as long, respectively, as corresponding outer teeth. Median portion of abdominal tergites strongly punctate in second-degree density, without distinct median impunctate band except on tergites III and IV; median furrow of epipygium shallow, very narrow. Posterior margin of abdominal sternites with a weak median extension. Hypopygium medially keeled.

Female, body, 25 to 26 millimeters long; anterior wing, 24 to 26.

The symbiotic acari, *Dinogamasus ramaleyi* LeVeq., found in the pouch of *X. bombiformis* F. Sm., is the same species found on *X. philippinensis* F. Sm. According to the findings of Miss LeVeque, in the case of the same species of acari taken from more than one species of bees, the hosts are very closely related. But judging from the female characters (I have not seen the male), there appears to be no true affinity between these two carpenter bees.

Specimens examined.—Los Baños, Baker, one female, Deutsches entomologisches Museum; Mamayan, one female, Stockholm Museum.

CHECK LIST OF THE PHILIPPINE SPECIES OF XYLOCOPA

Genus XYLOCOPA Latr. (1802)

Subgenus BILUNA Maa (1938)

XYLOCOPA (BILUNA) NASALIS FALLAX (Maidl) comb. nov.

"Philippine Islands" (Palawan?); males and females.

XYLOCOPA (BILUNA) NASALIS MCGREGORI (Ckll.).

LUZON; 1 male and 1 female.

XYLOCOPA (BILUNA) NASALIS MCGREGORI aber. THOMPSONI (Ckll.) comb. nov.

LUZON; 1 male.

XYLOCOPA (BILUNA) NASALIS MIMETICA (Ckll.) comb. nov.

PALAWAN; 1 male.

Subgenus ZONOHIRSUTA Maa (1938)

XYLOCOPA (ZONOHIRSUTA) MAZARREDOI Dusm.

PALAWAN; 1 female.

XYLOCOPA (ZONOHIRSUTA) COLLARIS FULIGINATA (J. Per.) comb. nov.

LUZON, MINDANAO, SAMAR, BASILAN, MINDORO, BOTEL TOBAGO; males and females.

XYLOCOPA (ZONOHIRSUTA) COLLARIS FULIGINATA aber. INDECISA (Ckll. et LeVeq.) comb. nov.

SAMAR; 1 female.

Subgenus ORBITELLA Maa (1938)

XYLOCOPA (ORBITELLA) TRIFASCIATA Grib.

MINDANAO; 1 female.

XYLOCOPA (ORBITELLA) GHILIANII (Grib.).

MINDANAO, SAMAR; 1 female.

XYLOCOPA (ORBITELLA) EUCHLORA J. Per.

MINDANAO, PALAWAN; 1 male.

XYLOCOPA (ORBITELLA) CANARIA (Ckll.-LeVeq.).

SAMAR; males and females.

XYLOCOPA (ORBITELLA) LUCBANENSIS (Ckll.) comb. nov.

LUZON; 1 female (? male).

XYLOCOPA (ORBITELLA) BLÜTHGENI Dusm.

MINDANAO, BASILAN; 1 female.

XYLOCOPA (ORBITELLA)) SAMARENSIS (Ckll.-LeVeq.) comb. nov.

SAMAR; 1 female.

XYLOCOPA (ORBITELLA), CHLORINA (Ckll.)

LUZON; males and females.

XYLOCOPA (ORBITELLA) CEBALLOSI Dusm.

LUZON; 1 female.

XYLOCOPA (ORBITELLA) TAYABANICA (Ckll.) comb. nov.

LUZON; 1 female.

XYLOCOPA (ORBITELLA) BILINEATA (Friese).

LUZON; 1 female.

XYLOCOPA (ORBITELLA) PHILIPPINENSIS F. Sm.

LUZON; 1 female.

XYLOCOPA (ORBITELLA) NEGLIGENDA Maa.

TAYANITO MAI; 1 female.

XYLOCOPA (ORBITELLA) ADUSTA J. Per.

MINDANAO; 1 female.

XYLOCOPA (ORBITELLA) OCCIPITALIS J. Per.

MINDANAO; 1 male.

XYLOCOPA (ORBITELLA) SUBVOLATILIS (Ckll.) comb. nov.

MINDANAO; 1 female.

XYLOCOPA (ORBITELLA) QUERNOSENSIS (Ckll.).

NEGROS, PANAY, CEBU; 1 female.

XYLOCOPA (ORBITELLA) DAPITANENSIS (Ckll.) comb. nov.

MINDANAO; 1 female.

XYLOCOPA (ORBITELLA) BAKERIANA (Ckll.) comb. nov.

LUZON; males and females.

XYLOCOPA (ORBITELLA) SULCIFRONS J. Per.

PALAWAN; 1 female.

XYLOCOPA (ORBITELLA) AMAUROPTERA J. Per.

PALAWAN; 1 female.

XYLOCOPA (ORBITELLA) VACHALI J. Per.

PALAWAN; 1 female.

XYLOCOPA (ORBITELLA) BOMBIFORMIS F. Sm.

LUZON; males and females.

Subgenus PLATYNOPODA Westw. (1840)

XYLOCOPA (PLATYNOPODA) LATIPES (Drury).

NEGROS, PALAWAN; males and females.

SPECIES WRONGLY OR DOUBTFULLY RECORDED FROM THE PHILIPPINE ISLANDS

Xylocopa (*Nyctomelitta*) *tranquebarica* (Fabr.).
Xylocopa (*Biluna*) *nasalis nasalis* Westw.
Xylocopa (*Biluna*) *nasalis iridipennis* (Lepel.).
Xylocopa (*Zonohirsuta*) *collaris collaris* Lepel.
Xylocopa (*Zonohirsuta*) *collaris nigrocærulea* (F. Sm.).
Xylocopa (*? Zonohirsuta*) *sororina* F. Sm.
Xylocopa (*Alloxylocopa*) *appendiculata* F. Sm.
Xylocopa (*Orbitella*) *ceylonica* Cam. (= *Clavicrus* Maidl).
Xylocopa (*Orbitella*) *confusa* J. Per.
Xylocopa (*Orbitella*) *bryorum* (Fabr.).
Xylocopa (*Orbitella*) *tricolor* Rits.
Xylocopa (*Orbitella*) *leucocephala* Rits.
Xylocopa (*Platynopoda*) *tenuiscapa* Westw.

A NEW ANTENNOPHORID MITE, RIDER OF THE PHILIPPINE ANT ÆNICTUS MARTINI

By ARTHUR PAUL JACOT

Of the United States Forest Service, New Haven, Connecticut

ONE TEXT FIGURE

The specimens on which this paper is based were sent me by Dr. J. W. Chapman, of Siliman University, with a request for determination. After several futile attempts at determining the genus, I sent the specimens to Dr. Hermann Graf Vitzthum for determination, and description, if new. Doctor Vitzthum returned them to me with the advice that he thought they represent a new family related to the antennophorids, certainly a new subfamily of this group. As I am not familiar with this family I am unable to characterize such a group but proceed to describe the species and genus.

Genus ÆNICTEQUES novum

Body elongate, oval, depressed; dorsal shield of male narrower and shorter than ventral, produced anteriad over mouth parts which are invisible from above and seem much reduced; legs 1 long, stout, tarsus the longest segment, without ambulacrum or claws; stigmata posterolaterad of legs 4; male genital aperture on transverse plane passing between legs 2 and 3 (text fig. 1, *a*) ; female genital area formed of a median triangular plate, a lateral plate (each side) which is broadest at anterior end and bears two bristles, and an anterior transverse plate (text fig. 1, *e*) ; ambulacra of legs 2 to 4 without hooks (text fig. 1, *b*).

Type: *Aenicteques chapmani* sp. nov.

ÆNICTEQUES CHAPMANI sp. nov.

Body sculptured with net pattern, armed with short and long bristles (text fig. 1, *a*) ; plates of dorsum and venter joined by unpigmented membrane; anterior edge of dorsal plate with a pair of bristle-bearing nubbins (text fig. 1, *a*) ; sides with a series of such nubbins; lateral plate (parapodial?) of venter armed on transverse plane passing between legs 2 and 3 with a triangular, distally emarginate spur which projects beyond sides of body (text fig. 1, *a*) ; dorsal plate with a marked, transverse depression behind transverse plane of legs 4; a deep constriction

between ventral and thoracic (epigynal and lateral) plates; center of thoracic (sternal) plate of males longitudinally depressed; transverse plate of genital area of females smooth; a cluster of pseudofissuræ (lyriform organs) at anterolateral corners of lateral plates of females; distal end of tarsi 1 furnished with short, stout, curved bristles (text fig. 1, *d*); coxæ of legs 1 with prominent ventrolateral angles especially at proximal end (text fig. 1, *a*).

Females bear a maximum of three eggs at one time.

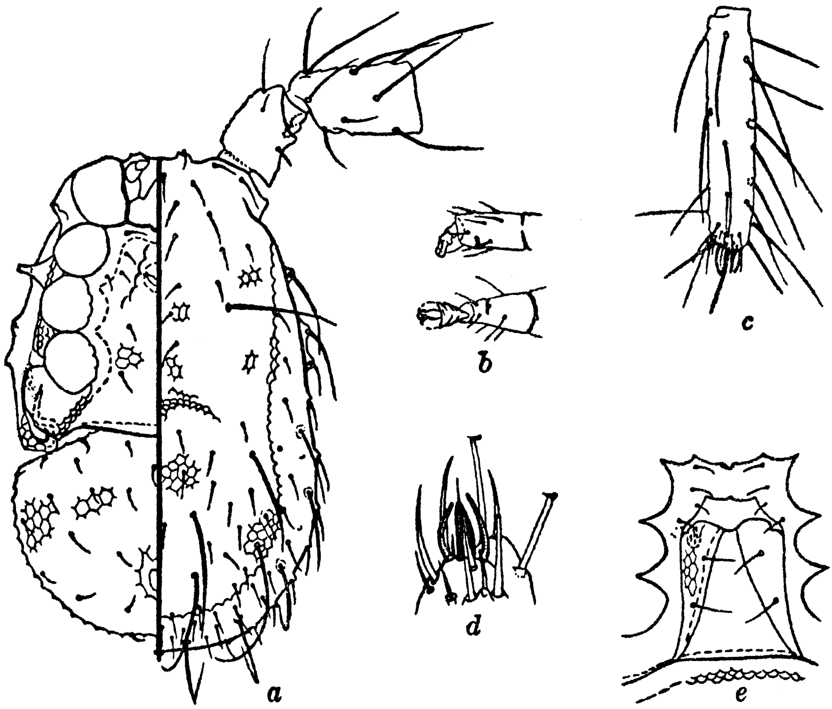

FIG. 1. *Ænicteques chapmani* gen. et sp. nov. *a*, Dorsoventral aspects of male, legs omitted; *b*, distal half of tarsi 3 and 4, lateral aspect above, dorsal aspect below; *c*, tarsus 1, dorsal aspect; *d*, distal end of tarsus 1, 4.4 times larger than in *c*; *e*, ventral aspect of ventral plates of female thorax.

Largest female, length, 1 millimeter; breadth, 0.7.

Male, length, 0.85 millimeter; breadth, 0.68.

Cotypes, 4 males, 17 females, taken by Dr. J. W. Chapman from workers of the ant *Ænictus martini* Forel, Philippines, mounted on two slides, to be deposited in the Museum of Comparative Zoölogy, Harvard University.

Doctor Chapman writes that the mites ride astraddle the head of the workers with legs extended forward and frequently palpated by the antennæ of the ant.

ILLUSTRATION

TEXT FIGURE

FIG. 1. *Ænicteques chapmani* gen. et sp. nov. *a*, Dorsoventral aspects of male, legs omitted; *b*, distal half of tarsi 3 and 4, lateral aspect above, dorsal aspect below; *c*, tarsus 1, dorsal aspect; *d*, distal end of tarsus 1, 4.4 times larger than in *c*; *e*, ventral aspect of ventral plates of female thorax.

OCCURRENCE AND SEASONAL DISTRIBUTION OF MARINE PLANKTONIC DIATOMS FROM TSINGTAO AND ITS VICINITY

By T. G. CHIN

Of the Marine Biological Station, University of Amoy, China

ONE TEXT FIGURE

The planktonic diatoms listed in this paper were collected at Tsingtao and its vicinity, in northeastern China, 36° 5′ north latitude and 120° 18′ east longitude, from the localities of Little Tsingtao, Great Wharf, Small Wharf, and Chang Kao. The two first-named localities contributed most of the samples, while the latter two yielded only one collection each. Altogether thirty-nine samples were examined, from May, 1936, to March, 1937. Fifty-seven species of diatoms were found, 18 of them not found in Amoy waters.[1]

Sincere thanks are due to Dr. S. W. Ling, former head of the Department of Biology, National University of Shantung, Tsingtao, for collecting the samples and for furnishing me a table of records relating to the samples, and to Dr. T. Y. Chen, Director of the Marine Biological Station, National University of Amoy, for valuable criticism.

PARALIA SCULATA (Ehr.) Cleve.

Paralia sculata (Ehr.) CLEVE (1873); CHIN (1937) 43, fig. 5.

Very rare in Little Tsingtao. Found in May and June, 1936, and February and March, 1937. Present in Amoy sea.

STEPHANOPYXIS PALMERINA (Grev.) Grunow.

Stephanopyxis palmerina (Grev.) GRUNOW (1884); CHIN (1937) 51, fig. 22.

Little Tsingtao, October and November, 1936. Rare. Common in Amoy.

STEPHANOPYXIS TURRIS (Grev. & Arn.) Ralfs.

Stephanopyxis turris (Grev. & Arn.) RALFS (1861); HUSTEDT (1928) 304, fig. 140.

Creswellia turris GREVILLE et ARNOTT (1857).

[1] Chin, Amoy Mar. Biol. Bull. (2) 3 (1937) 37–80.

Stephanopyxis appendiculata EHRENBERG (1854).
Stephanopyxis turgida RALFS (1861).
Stephanopyxis cylindrica EHRENBERG (1872).

Cells cylindrical, usually longer than broad. Diameter 45 μ, more or less. Areolæ 3 or 4 in 10 μ. Spines on each valve usually 9 or 10.

Little Tsingtao, common in October and November, 1936, rather rare in February, 1937. Not found in Amoy. First record for China Coast.

CYCLOTELLA STRIATA (Kütz.) Grunow.

Cyclotella striata (Kütz.) GRUNOW (1881); CHIN (1937) 49, fig. 18.

Little Tsingtao, rare; May, June, and October, 1936. Not common in Amoy.

SKELETONEMA COSTATUM (Grev.) Cleve.

Skeletonema costatum (Grev.) CLEVE (1878); CHIN (1937) 56, fig. 21.

Present in Little Tsingtao, Great Wharf, and Small Wharf, October, November, and December, 1936; and January, February, and March, 1937. Found in Amoy.

ACTINOCYCLUS RALFSII (W. Sm.) Ralfs.

Actinocyclus ralfsii (W. Sm.) RALFS, 1842; V. HEURCK (1896) 523, pl. 23, fig. 658.

Eupodiscus Ralfsii W. SM.

Cells disc-shaped, with large submarginal pseudonodule. Puncta interrupted by very numerous subulate hyaline spaces. Margin furnished with small spines, in every 10 μ. Puncta very fine, 14 in 10 μ. Diameter 100 to 130 μ.

Present in October in Little Tsingtao. Not reported from Amoy. First record for China Coast.

COSCINODISCUS EXCENTRICUS Ehrenberg.

Coscinodiscus excentricus EHRENBERG (1839); CHIN (1937) 45, fig. 7.

Present in October and December in Little Tsingtao. Recorded in Amoy plankton.

COSCINODISCUS LINEATUS Ehrenberg.

Coscinodiscus lineatus EHRENBERG (1838); CHIN (1937) 45, fig. 8.

Rare in Little Tsingtao and Chang Kao, in May, October, and November. Found in Amoy.

COSCINODISCUS JANISCHII A. Schmidt.

Coscinodiscus janischii A. SCHMIDT (1878); CHIN (1937) 46, fig. 10.

Rare in October and November, 1936, and March, 1937, in Little Tsingtao. Occurs in Amoy.

COSCINODISCUS ASTEROMPHALUS Ehrenberg.

Coscinodiscus asteromphalus EHRENBERG (1844); CHIN (1937) 46, fig. 11.

Little Tsingtao, October and December, 1936. Common in Amoy.

COSCINODISCUS RADIATUS Ehrenberg.

Coscinodiscus radiatus EHRENBERG (1839); GRAN (1905) 31, fig. 31; LEBOUR (1930) 39, fig. 15.

Cells flat, disc-shaped, 30 to 180 μ in diameter. No apicules. Areolæ uniform in size, 6 to 8 in 10 μ, radiating from the center. Oceanic.

Very common in Little Tsingtao and Great Wharf. Found nearly in every month. Not reported from Amoy. Recorded in Ningpoo, Chekiang, by Petit.

ACTINOPTYCHUS UNDULATUS (Bailey) Ralfs.

Actinoptychus undulatus (Bailey) RALFS (1861); CHIN (1937) 47, fig. 13.

Very rare in Little Tsingtao. Found only once in October, 1936. Present in Amoy.

CYCLOTELLA COMTA (Ehr.) Kützing.

Cyclotella comta (Ehr.) KÜTZING (1849); CHIN (1937) 49, fig. 17.

Only found once in November in Little Tsingtao. Found in Amoy.

LEPTOCYLINDRUS DANICUS Cleve.

Leptocylindrus danicus CLEVE (1889); GRAN (1905) 24, fig. 24; LEBOUR (1930) 77, fig. 52. GRAN and ANGST (1931) 457, fig. 35; ALLEN and CUPP (1935) 125, fig. 27.

Cells cylindrical, two to five times longer than broad, united in a straight chain. Valves flat or convex, without visible sculpturing. Diameter 6 to 11 μ. Chromatophores numerous. North temperate species. Neritic?

Rather rare in Little Tsingtao, in October, 1936, and January to March, 1937. Not found in Amoy. First record for China Coast.

RHIZOSOLENIA STOTERFORTHII H. Peragallo.

Rhizosolenia stoterforthii H. PERAGALLO (1888); CHIN (1937) 54, fig. 28.

Commonly found in Little Tsingtao, Great Wharf, and Small Wharf, in nearly every month. Also common in Amoy.

RHIZOSOLENIA ALATA fo. INDICA Brightwell.

Rhizosolenia alata fo. *indica* BRIGHTWELL (1858); CHIN (1937) 55, fig. 20.

Very common in Tsingtao and its vicinity; specimens found in every collection. Other forms of this species have never been found. Present in Amoy, but not as abundantly as in Tsingtao.

RHIZOSOLENIA SETIGERA Brightwell.

Rhizosolenia setigera BRIGHTWELL (1858); CHIN (1937) 56, fig. 33.

Present from October, 1936, to March, 1937, in moderate numbers. Collected from Little Tsingtao, Great Wharf, and Small Wharf. Occurs in Amoy.

CHAETOCEROS PERUVIANUS Brightwell.

Chaetoceros peruvianus BRIGHTWELL (1858); CHIN (1937) 58, fig. 36.

Found in Little Tsingtao, Great Wharf, and Small Wharf, from October, 1936, to March, 1937. Very rare. Rare also in Amoy.

Chain straight, 16 to 40 μ broad. Cells densely arranged, gaps small. Valve nearly rounded. Valve mantle low, girdle clearly separated from it by a constriction. Setæ thick, with spines, perpendicular to the chain. Chromatophores numerous, present in setæ. End cells different from the rest, by the valve being strongly rounded with the setæ arising near the center, or flat with the setæ arising near the margin. Oceanic, temperate.

Present from October, 1936, to March, 1937, in Little Tsingtao, Great Wharf, and Small Wharf. Not yet reported from Amoy. First record for China Coast.

CHAETOCEROS MITRA (Bail.) Cleve.

Chaetoceros mitra (Bail.) CLEVE (1896); GRAN (1905) 75, fig. 89; IKARI (1928) 258, fig. 12; LEBOUR (1930) 128, fig. 92; HUSTEDT (1930) 677, fig. 384.

Dicladia Groenlandicus CLEVE (1873).

Dicladia mitra BAILEY (1880).

Vegetative cells very much like *C. decipiens*, but the resting spores different. Valve faces of resting spores different, primary valve elevated into two large cones, bearing a solid stem

and many branches, secondary valve smooth and vaulted, with two low peaks.

Only one chain with spores found October 6, 1936, in Little Tsingtao. Not found in Amoy. First record for China Coast.

CHAETOCEROS TERES Cleve.

Chaetoceros teres CLEVE (1896); GRAN (1905) 76, fig. 91; IKARI (1928) 260, fig. 13*a;* LEBOUR (1930) 130, fig. 94; HUSTEDT (1930) 681, fig. 386.

Chain straight, 18 to 48 μ broad. Gaps usually very narrow. Cells oblong in broad girdle view with sharp corners. Setæ thin, almost perpendicular to the chain, arising obliquely on both sides of the apical plane. Valve mantle low, girdle zone high, no constriction between. Chromatophores numerous. Neritic. North temperate species.

Present in October in Little Tsingtao. Not found in Amoy. Reported from Japan. First record for China Coast.

CHAETOCEROS PSEUDOCURVISETUM Manguin.

Chaetoceros pseudocurvisetum MANGUIN (1910); IKARI (1926) 529, fig. 12; LEBOUR (1930) 159, fig. 122*a;* HUSTEDT (1930) 739, fig. 427.

Chains curved, cells compressed, slightly fused at their corners. Valve with four protuberances connected with similar knobs on adjacent valve. Gaps lenticular. Neritic.

Present in October in Little Tsingtao. Not found in Amoy. Reported from Japan. First record for China Coast.

CHAETOCEROS CURVISETUM Cleve.

Chaetoceros curvisetum CLEVE (1889); LEBOUR (1930) 156, fig. 120; GRAN (1905) 91, fig. 116; HUSTEDT (1930) 737, fig. 426.

Chains curved, 10 to 29 μ broad. End cells not differentiated. Cells oblong in broad girdle view, with conspicuous corners. Gaps rhombo-elliptical to circular. Setæ all bent towards same side of chain. Chromatophores 1 per cell. Neritic. Temperate.

October 16, 1936. Very rare. Not found in Amoy. First record for China Coast.

CHAETOCEROS LORENZIANUS Grunow.

Chaetoceros curvisetum CLEVE (1889); LEBOUR (1930 156, fig. 120; LEBOUR (1930) 128, fig. 93; HUSTEDT (1930) 679, fig. 385.

Chains straight, usually short, 20 to 50 μ broad. Gaps polygonal to elliptical. Setæ enlarged near ends, strongly punctate, especially terminal setæ.

October 16, 1936; very rare. Not found in Amoy. Recorded in Hongkong by Lauder.

CHAETOCEROS BREVIS Schütt.

Chaetoceros brevis SCHÜTT (1895); GRAN (1905) 83, fig. 100; LEBOUR (1930) 139, fig. 101; HUSTEDT (1930) 707, fig. 403.

Chains straight, 20 μ broad, gaps oval to oblong. Valve center slightly projected. Setæ thin, arising near corners, joined with adjacent cells. Chromatophore 1. Neritic. Temperate.

October 16, 1936. Very rare. Not found in Amoy. First record for China Coast.

CHAETOCEROS DITYMUS Ehrenberg.

Chaetoceros ditymus EHRENBERG (1845); CHIN (1937) 60, fig. 42.

Found only October 16, 1936, in Little Tsingtao. Present in Amoy.

CHAETOCEROS EIBENII (Grun.) Chin.

Chaetoceros eibenii (Grunow, 1881); CHIN (1937) 58, fig. 38.

Only once collected from Great Wharf, March 6, 1937. Present in Amoy.

CHAETOCEROS DECIPIENS Cleve.

Chaetoceros decipiens CLEVE (1873); CHIN (1937) 60, fig. 43.

Little Tsingtao, Great Wharf, and Small Wharf, from October, 1936, to March, 1937. Occurs in Amoy.

CHAETOCEROS AFFINIS var. WILLEI (Gran) Hustedt.

Chaetoceros affinis var. *Willei* (Gran) HUSTEDT (1930); HUSTEDT (1930) 697, fig. 398; GRAN (1905) 81, fig. 98.
Chaetoceros Willei GRAN (1897).

Chains straight, 10 to 20 μ broad. Cells delicate, gaps between cells small, setæ scarcely thickened. Other characters resembling *C. affinis*.

Little Tsingtao, December 1, 1936. Not found in Amoy. First record for China Coast.

CHAETOCEROS AFFINIS var. CIRCINALIS (Meunier) Hustedt.

Chaetoceros affinis var. *circinalis* (Meunier) HUSTEDT (1930) 697, fig. 397.
Chaetoceros Schuttii var. *circinalis* MEUNIER (1913).

Setæ curved, perpendicular to the chain, meeting each other in the valve view to take the shape of a section of a spinal cord.

Present in October and November, 1936. Not found in Amoy. First record for China Coast.

CHAETOCEROS DENSUS Cleve.

Chaetoceros densus CLEVE (1901); GRAN (1905) 67, fig. 79; LEBOUR (1930) 115, fig. 81; HUSTEDT (1930) 651, fig. 368.
Chaetoceros borealis var. *densa* CLEVE (1897).

BACTERIASTRUM HYALINUM Lauder.

Bacteriastrum hyalinum LAUDER (1864); CHIN (1937) 53, fig. 25.

Little Tsingtao, October and November, 1936; rare. Common in Amoy.

TRICERATIUM FAVUS Ehrenberg.

Triceratium favus EHRENBERG (1841); CHIN (1937) 63, fig. 50.

Little Tsingtao, October 16, 1936, and January 1, 1937. Occurs in Amoy.

DITYLIUM BRIGHTWELLII (West) Grunow.

Ditylium brightwellii (West) GRUNOW (1881); CHIN (1937) 65, fig. 55.

Little Tsingtao, common from October to December, 1936, and February, 1937. Also common in Amoy.

DITYLIUM SOL Grunow.

Ditylium sol GRUNOW (1881); CHIN (1937) 66, fig. 56.

Little Tsingtao, Small Wharf, and Great Wharf, January, February, and March, 1937. Rather rare in Amoy.

BIDDULPHIA LAEVIS Ehrenberg.

Biddulphia laevis EHRENBERG (1843); CHIN (1937) 61, fig. 45.

Little Tsingtao, October 16, 1936, and Great Wharf, January 1, 1937; very rare. Occurs in Amoy.

BIDDULPHIA SINENSIS Greville.

Biddulphia sinensis GREVILLE (1886); CHIN (1937) 62, fig. 46.

Little Tsingtao, common from October to December, 1936; less common in February and March, 1937. Very common in Amoy.

BIDDULPHIA MOBILIENSIS (Bail.) Grunow.

Biddulphia mobiliensis (Bail.) GRUNOW (1885); CHIN (1937) 62, fig. 48.

Little Tsingtao, October to December, 1936, and February, 1937; very rare. Rare in Amoy plankton.

HEMIAULUS HAUCKII Grunow.

Hemiaulus hauckii GRUNOW (1881); CHIN (1937) 64, fig. 52.

Little Tsingtao, October, 1936; very rare. Present in Amoy.

HEMIAULUS SINENSIS Greville.

Hemiaulus sinensis GREVILLE (1865); CHIN (1937) 64, fig. 53.

Little Tsingtao, May to November, 1936; very rare. Present in Amoy.

EUCAMPIA ZODIACUS Ehrenberg.

Eucampia zodiacus EHRENBERG (1839); CHIN (1937) 66, fig. 57.

Found only once, October 6, 1936, in Little Tsingtao; rare. Commonly collected in Amoy waters.

STREPTOTHEA THAMENSIS Shrubs.

Streptothea thamensis SHRUBS (1890); GRAN (1905) 101, fig. 131; LEBOUR (1930) 191, fig. 150.

Cells almost square, flat, strongly twisted. Valve with knobs which fit into corresponding depressions in the adjacent cells. Chain 40 to 120 μ broad. Neritic. Arctic species.

Little Tsingtao, common in October and November, 1936. Not reported from Amoy. First record for China Coast.

FRAGILARIA STRIATULA Lyngbye.

Fragilaria striatula LYNGBYE (1819); CHIN (1937) 68, fig. 60.

Only found twice in Little Tsingtao, June and November, 1936; rare. Rare also in Amoy.

ASTERIONELLA JAPONICA Cleve.

Asterionella japonica CLEVE (1882); CHIN (1937) 69, fig. 62.

Found in October, 1936, and February and March, 1937. Very rare in Little Tsingtao and Small Wharf, but very common in Great Wharf. Rare in Amoy.

THALASSIOTHRIX LONGISSIMA Cleve and Grunow.

Thalassiothrix longissima CLEVE & GRUNOW (1880); CHIN (1937) 70, fig. 66.

Great Wharf, March 12, 1937. Occurs in Amoy.

THALASSIOTHRIX FRAUENFELDII (Grunow) Cleve and Grunow.

Thalassiothrix frauenfeldii (Grunow) CLEVE & GRUNOW (1880); CHIN (1937) 70, fig. 66.

Present in Little Tsingtao and Great Wharf. Commonly collected in Amoy.

THALASSIOTHRIX NITZSCHIOIDES Grunow.

Thalassiothrix nitzschioides GRUNOW (1881); CHIN (1937) 71, fig. 67.

Occurs in every month in limited numbers, in Little Tsingtao, Great Wharf, and Small Wharf. Occurs in Amoy waters.

GRAMMATOPHORA MARINA (Lyngbye) Kützing.

Grammatophora marina (Lyngbye) KÜTZING (1844); CHIN (1937) 71, fig. 68.

Little Tsingtao, June, 1936, and February, 1937; very rare. Rare in Amoy.

RHABDONEMA ADRIATICUM Kützing.

Rhabdonema adriaticum KÜTZING (1844); LEBOUR (1930) 202, fig. 104.

Cells in chains, with numerous curved septa and transverse rows of puncta. Valves linear-lanceolate, somewhat thickened at ends. Littoral. Temperate.

Little Tsingtao, June and October, 1936; very rare. Not reported from Amoy.

LICMOPHORA ABBREVIATA Agardh.

Licmophora abbreviata AGARDH (1867); CHIN (1937) 72, fig. 69.

Very common and usually abundant in Little Tsingtao and Great Wharf. Collected in every month. Present in Amoy.

COCCONEIS SCUTELLUM Ehrenberg.

Cocconeis scutellum EHRENBERG (1838); CHIN (1937) 73, fig. 72.

Only once collected in Little Tsingtao, June 2, 1936; very rare. Rare also in Amoy.

NAVICULA CANCELLATA Donkin.

Navicula cancellata DONKIN (1871); CHIN (1937) 74, fig. 74.

Rarely found in Tsingtao region. Rare in Amoy.

PLEUROSIGMA ANGULATUM W. Sm.

Pleurosigma angulatum W. SM. (1852); V. HEURCK (1896) 251, pl. 6, fig. 257.

Valve broadly lanceolate, sigmoid, median part slightly angular. Raphe sigmoid. All striæ almost equally delicate, 18 to 20 in 10 μ. Median oblique striæ not flexed. Length 150 to 190 μ. Neritic. North temperate.

Usually found in limited numbers. Not found in Amoy. Recorded in Foochow by Skvortzow.

PLEUROSIGMA AFFINE Grunow.

Pleurosigma affine GRUNOW (1873); V. HEURCK (1896) 252, pl. 6, fig. 263.

This species is very much like *P. angulatum,* but with more lanceolate and rather finer striæ, and with median oblique striæ flexed. Length 100 to 220 μ.

Very rare in Tsingtao. Not found in Amoy. Recorded in Nimrod Sound, Chekiang, by Petit, and in Dairen by Skvortzow.

BACILLARIA PARADOXA Gmelin.

Bacillaria paradoxa Gmelin (1788); CHIN (1937) 76, fig. 78.

Usually found in limited numbers in Little Tsingtao and in Great Wharf. Common in Amoy.

NITZSCHIA LONGISSIMA (Breb.) Gran.

Nitzschia longissima (Breb.) GRAN (1861); CHIN (1937) 76, fig. 79.

Little Tsingtao and Great Wharf, October, 1936, and January and February, 1937; very rare. Found in Amoy.

NITZSCHIA SERIATA Cleve.

Nitzschia seriata CLEVE (1883); CHIN (1937) 77, fig. 80.

Found in nearly every month in Little Tsingtao, Great Wharf, and Small Wharf. Also occurs in Amoy plankton.

NITZSCHIA DELICATISSIMA Cleve.

Nitzschia delicatissima CLEVE (1897); GRAN (1905) 130; LEBOUR (1930) 214, fig. 179.

Cells hairlike, very similar to those in *Nitzschia seriata,* but slenderer; 1.5 μ broad. Neritic.

Found only once, March 12, 1937, in Great Wharf. Not found in Amoy. First record for China Coast.

MONTHLY DISTRIBUTION

May, 1936.—Three collections were made at Little Tsingtao and one at Chun Kuo, each containing 3 to 5 species and very few individuals for each species. Most of the species found were different, so that a total of 10 species were obtained in this month.

June, 1936.—Ten collections were made in June, 1936, one of them from Great Wharf and the rests from Little Tsingtao. Only 16 species of diatoms were found, since each sample contained very few species and since most samples contained iden-

tical species. The number of individuals found during this month was the lowest in the present study.

July to September, 1936.—No sample was obtained during July to September, 1936, but the period was quite important because of the multiplication of diatoms, and the maximum of diatoms having occurred in this period. From the known data, especially for June and October, the writer believes diatoms increased suddenly in July and gradually in August, and reached the maximum in September or in October.

October, 1936.—Forty-seven species were found in October, 1936, in 5 samples from Little Tsingtao, and the number of individuals in each collection was also very high. Therefore October was probably the optimum month of the year for diatoms.

November, 1936.—Two collections were made in November, 1936, from Little Tsingtao, containing 26 species, but the average number of individuals in each collection was a little lower than in October.

December, 1936.—Only 1 sample was collected in December, 1936, from Little Tsingtao, containing 18 species, not much less than the average number for the preceding months, and the average number of individuals in each collection was the same as in October.

January, 1937.—Twelve species were found in January, 1937, in a single collection taken at Great Wharf. Both the number of species and the number of individuals were decreasing gradually.

February, 1937.—From the 5 collections made in February, 1937, in Little Tsingtao, Great Wharf, and Small Wharf, 25 species were obtained. The average number of species was less than that taken in January, and the average number of individuals was much less than that taken in the preceding months.

March, 1937.—Thirty-three species were found in March, 1937, in 11 collections from Little Tsingtao and Great Wharf. Both the average number of species and the average number of individuals were much less than those taken in February.

April, 1937.—No sample was available for study in April, 1937, but from the data of March, 1937, and May, 1936, the writer believes there was very little change, and the curve for diatoms must be smooth.

TABLE 1.—*Locality and date records of diatoms taken at Tsingtao and vicinity.*

Date.	Time of day.	Locality.	Collection No.	Ling & Su's Remarks.
		1936		
May 20	3–5 P. M.	Little Tsingtao	2	
May 22	3–5 P. M.	Chang Kao	3	
May 24	P. M.	Little Tsingtao	4	
May 29	P. M.	do	6	
June 2	P. M.	do	7	
June 3	8–10 P. M.	do	8	
June 4	3–5 P. M.	do	9	
June 5	2–4 P. M.	do	10	
June 6	2–4 P. M.	do	11	
June 6	7–9 P. M.	do	12	
June 9	2–4 P. M.	do	13	
June 12	3–5 P. M.	do	14	
June 13	3–6 P. M.	do	15	
June 18	9–11 A. M.	do	16	
October 6		do	A 1	
October 12	8 P. M.	do	A 2	
October 15		do	A 3	
October 16		do	A 4	
October 18		do	A 5	
November 10		do	A 6	
November 16		do	A 7	
December 1		do	17	Below 0° C.
		1937		
January 1		Great Wharf	18	Below 0° C.
February 19	3–5 P. M.	Little Tsingtao	19	
February 19	8–19 P. M.	do	20	
February 20	4–6 P. M.	Great Wharf	21	
February 20	6–7 P. M.	Small Wharf	22	
February 27	7–9 P. M.	Little Tsingtao	23	Along the coast.
March 1	4–6 P. M.	Great Wharf	24	
March 1	4–6 P. M.	do	25	Fine net.
March 1	7–9 P. M.	do	26	
March 1	7–9 P. M.	do	27	Do.
March 6	10–12 A. M.	do	28	
March 12	10–12 A. M.	do	29	
March 12	10–12 A. M.	do	30	Do.
March 21	10–12 A. M.	Little Tsingtao	31	
March 22	2–5 P. M.	Great Wharf	32	
March 28	10–12 A. M.	do	33	
March 28	6–8 P. M.	do	34	

DISCUSSION AND SUMMARY

1. Of the 57 species described, only 6 occurred more than fifteen times (that is, were present in more than half of the samples examined), namely, *Rhizosolenia alata* fo. *indica, R. stoterforthii, Thalassiothrix nitzschioides, Licmophora abbreviata, R. setigera,* and *Biddulphia sinensis.* These predominant species were cosmopolitan and also recorded in Amoy, but the periods of their maxima were different.

2. Eighteen species of diatoms from Tsingtao were not recorded from Amoy, namely, *Stephanopyxis turris, Actinocyclus Ralfsii, Coscinodiscus radiatus, Leptocylindrus danicus, Coscinodiscus affinis* var. *Willei, Chaetoceros affinis* var. *circinalis, Ch. densus, Ch. mitra, Ch. teres, Ch. pseudocurvisetum, Ch. curvisetus, Ch. Lorenzianus, Ch. brevis, Streptothea thamensis, Rhabdonema adriaticum, Pleurosima affine, Pl. angulatum,* and *Nitzschia delicatissima.* The rests were reported from Amoy.

3. The maximum period for the average number of species (21) and the average number of individuals (45) found monthly occurred in October. However, the writer believes that the maximum occurred in September, since no collection was made during that month. The minimum period occurred in June. As compared with the collections of Amoy planktonic diatoms, the seasons for the maximum and minimum occurred two or three months later in Tsingtao, which is north of Amoy. The seasonal distribution is shown in Table 2 and in text fig. 1.

TABLE 2.—*Seasonal distribution of planktonic diatoms at Tsingtao and vicinity.*

Data.	1936		1937							
	May.	June.	July–Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Number of species found	10	16	------	47	26	18	12	25	23	------
Collections made	4	10	------	5	2	10	1	5	11	------
Species for each collection in average.	4.2	4	------	21.4	19	18	12	11.6	7.1	------
Average individuals in each collection.	9	7	------	45	42	45	30	21	13	------

4. With regard to the time of day, afternoon collections on the surface gave the best results (an average of 10.6 species), followed by evening (an average of 7.5 species) and morning (an average of 7.3 species) collections, as penetration of light was best in the afternoon.

5. Samples collected December 1, 1936, and January 1, 1937, showed no difference from the other samples, although the temperature of sea water was below 0° C. Although the sample collected February 27, 1937, was taken along the coast, the diatoms taken were no less abundant in it than in samples taken away from the coast.

TABLE 3.—*Details of the collections of marine planktonic diatoms from Tsingtao and vicinity.*

[rr=very rare; r=rare; x=present; c=common; cc=very common; ccc=abundant.]

Species.	1936																					
	May.				June.										October.					November.		December.
	20	22	24	29	2	3	4	5	6	6	6	12	13	18	6	12	15	16	18	10	16	1
Paralia sculata				r	rr			rr														
Stephanopyxis Palmerina																rr		rr			rr	
Stephanopyxis turris															c	c	rr	x	x	rr	rr	
Cyclotella striata	rr				rr										rr							
Skeletonema costatum															r			rr			rr	c
Actinocyclus Ralfsii																		rr				
Coscinodiscus excentricus															c							rr
Coscinodiscus lineatus	rr		rr												rr					r		
Coscinodiscus janischii															rr	rr		c			rr	
Coscinodiscus asteromphalus															cc							r
Coscinodiscus radiatus						rr									c		rr	ccc	ccc	c	c	
Actinoptychus undulatus																		rr				
Cyclotella comta																					x	
Leptocylindrus danicus															rr	rr	rr		rr			
Rhizosolenia stolterforthii					rr		x	x	rr	rr					cc			x	c	x	r	c
Rhizosolenia alata fo. *indica*	c	x	c	x	x	rr	c	c	x	x	r	rr	rr	rr	c	r	rr	x	c	r	r	x
Rhizosolenia setigera															x	r	rr	x	r	rr	rr	c
Chaetoceros peruvianus															x			rr		rr		r
Chaetoceros didymus																		rr				
Chaetoceros eibenii																						
Chaetoceros decipiens															x		rr	rr	x	rr	x	c
Chaetoceros affinis var. *Willei*																						x
Chaetoceros affinis var. *circinalis*															rr			x		c		
Chaetoceros densus															x						x	r
Chaetoceros mitra															rr							

Chaetoceros teres															x			x				
Chaetoceros pseudocurvisetum															x			c				
Chaetoceros curvisetum																		rr				
Chaetoceros lorenzianus																		rr				
Chaetoceros brevis																		rr				
Bacteriastrum hyalium															x			rr		rr	rr	
Triceratium favus																	rr			r		rr
Ditylium Brightwellii															x	rr	rr	r	x	cc	x	c
Ditylium sol																						
Biddulphia laevis																		rr				
Biddulphia sinensis															x	rr	rr	x	cc	ccc	c	cc
Biddulphia mobiliensis															rr	rr		rr	rr	r	rr	rr
Hemiaulus hauckii															rr			rr				
Hemiaulus chinensis			rr				rr	r							r			rr	rr		rr	
Eucampia zodiacus															rr							
Streptotheca thamensis															x			c		rr		
Fragilaria striatula					x															rr		
Asterionella japonica															r			rr				
Thalassiothrix longissima																						
Thalassiothrix frauenfeldii															r	x		r	x	r	x	
Thalassiothrix nitzschioides	r		rr	r	r										rr		r	c	x	r		x
Grammatophora marina								r														
Rhabdonema adriaticum								rr										rr				
Licmophora abbreviata				x	ccc	rr			rr		x	rr	rr				rr				x	rr
Cocconeis scutellum					rr																	
Navicula cancellata	rr	x					rr	rr	rr					rr			rr					rr
Pleurosigma Normanii			rr																			
Pleurosigma affine		x								rr		rr			rr		rr	rr	rr			
Bacillaria paradoxa											rr				rr		rr	r	x	r	rr	rr
Nitzschia longissima																rr						
Nitzschia seriata					rr												rr					
Nitzschia delicatissima																						
Number of species found.	5	3	5	4	9	3	4	7	4	3	3	3	2	2	33	11	15	33	15	19	19	18

TABLE 3.—*Details of the collections of marine planktonic diatoms from Tsingtao and vicinity*.—Continued.

Species.	1937																	Number of collections made.
	January.	February.					March											
	1	19	19	20	20	27	1	1	1	1	6	12	12	21	22	28	28	
Paralia sculata				rr												rr		5
Stephanopyxis Palmerina																		3
Stephanopyxis turris			rr															8
Cyclotella striata																		3
Skeletonema costatum	x	cc		ccc	rr	rr		r			rr			x				12
Actinocyclus Ralfsii																		1
Coscinodiscus excentricus																		2
Coscinodiscus lineatus																		4
Coscinodiscus janischii														rr				5
Coscinodiscus asteromphalus																		2
Coscinodiscus radiatus	rr		rr			rr				rr				x				12
Actinoptychus undulatus																		1
Cyclotella comta																		1
Leptocylindrus danicus	r							rr					rr	cc				8
Rhizosolenia stoterforthii	x	r	rr	r	x			cc	rr	rr	rr		cc	r	rr			23
Rhizosolenia alata fo. *indica*	x	c	c	x	x	rr	rr	c	rr	r	rr	rr	c	x	r	rr	rr	39
Rhizosolenia setigera		r	r	r	r	rr		rr		r	rr		c	r			rr	19
Chaetocerus peruvianus					rr			rr					r					7
Chaetoceros ditymus																		1
Chaetoceros eibenii											rr							1
Chaetoceros decipiens					rr			r		rr			x	rr				12
Chaetoceros affinis var. *Willei*																		1
Chaetoceros affinis var. *circinalis*																		3
Chaetoceros densus			rr		rr			rr			rr		rr					8
Chaetoceros mitra																		1

Chaetoceros teres																		2
Chaetoceros pseudocurvisetum																		2
Chaetoceros curvisetum																		1
Chaetoceros lorenzianus																		1
Chaetoceros brevis																		1
Bacteriastrum hyalium																		4
Triceratium favus	rr																	4
Ditylium Brightwellii		rr	rr															10
Ditylium sol	x		rr	c	rr			c		r	rr		c	r				9
Biddulphia laevis	rr									rr			rr	rr				2
Biddulphia sinensis		rr	rr	r				rr										15
Biddulphia mobiliensis			rr															8
Hemiaulus hauckii																		2
Hemiaulus chinensis																		7
Eucampia zodiacus																		1
Streptotheca thamensis																		3
Fragilaria striatula																		2
Asterionella japonica		rr			r			cc		r			ccc					7
Thalassiothrix longissima													x					1
Thalassiothrix frauenfeldii	x		x	rr		rr						rr		x				12
Thalassiothrix nitzschioides	x	rr	x	x	rr	rr		r	rr	rr	rr		r		rr			22
Grammatophora marina		rr																2
Rhabdonema adriaticum																		2
Licmophora abbreviata	cc	rr	ccc	r		x	rr		rr			rr	r	x			rr	21
Cocconeis scutellum																		1
Navicula cancellata		rr				rr	rr											11
Pleurosigma Normanii																		1
Pleurosigma affine		rr																8
Bacillaria paradoxa				rr						rr								10
Nitzschia longissima	r	rr																3
Nitzschia seriata					x			r					rr					5
Nitzschia delicatissima													rr					1
Number of species found	12	14	13	11	11	8	3	13	4	10	9	3	17	10	3	2	3	.

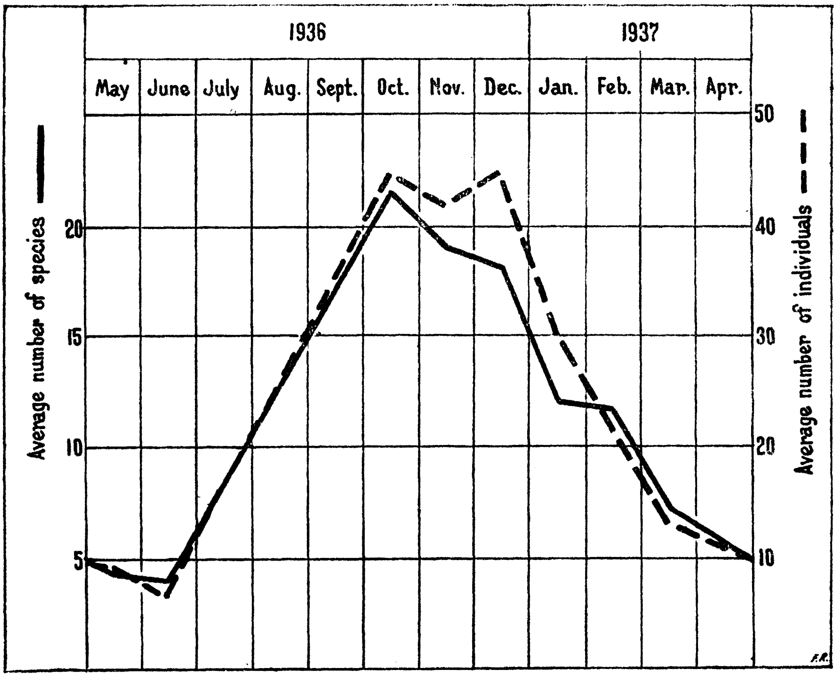

FIG. 1. Average number of species and individuals found in each collection.

6. The net used in collecting diatoms was important, as is shown clearly in Ling & Su's Nos. 24 and 25 (from 4 to 6 P. M., March 1, 1937), 26 and 27 (7 to 8.30 P. M., March 1, 1937), and 29 and 30 (10 to 12 A. M., March 12, 1937). The number of species collected by the fine net was four times as great as that taken with the ordinary net. Therefore, with the use of a fine net the number of species obtained would be far greater than the number of species reported here.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Average number of species and individuals found in each collection.

MARINE PLANKTONIC DIATOMS FROM CHINA COAST

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The planktonic diatoms listed in the present paper were collected from Shantung and Fukien Coast. Twelve samples were collected, containing 105 species of diatoms, 24 of them new for China Coast. Four species were recorded from brackish water, which were not unreasonably found in the coastal sea water. The new and rare species found in the samples mentioned below will be described later.

Samples 6 to 11 were collected by a small fishing boat. The time devoted to each trip was probably very short, and therefore yielded very few species of diatoms. Sample 13 contains numerous species, probably because the collecting trip was made in August, when diatoms are abundant.

Sample 1.—Collected from Chefoo, Shantung, July 11, 1936. Seventeen species of diatoms were obtained. The number of individuals for each species was very small, since the zoöplankton was predominant in July in Shantung region.

Sample 2.—Collected from Wha Hai Wha, Shantung, July 14, 1936. Fourteen species of diatoms were obtained on this trip, under conditions very much like those obtaining at the collection of sample 1.

Sample 3.—Collected from White Shore on the eastern side of Haitan Island, and north of the Ox Mountain Light House, at 2.30 to 3 P. M., May 24 and 25, 1937. Where the water was clear, the temperature was 23° C., the transparency 17 feet, and the density 1.0214. Thirty-seven species were collected, and the number of individuals was relatively large.

Sample 4.—Collected near Green Isle, on the eastern shore of Haitan Island, May 6 and 9, 1936. Sixteen species were observed.

Sample 5.—Collected from Ox Mountain Light House, Haitan, at 2.30 to 3 P. M., May 11 and 12, 1937. Where the water was clear, the temperature was 22.1° C., the transparency 18.5 feet, and the density 1.0215. Ten species were found.

Sample 6.—Collected in a fishing ground on the eastern side of Amoy Light House, Amoy, April 25, 1936. In this sample zoöplankton was predominant, mostly Noctiluca and Copepoda. Very few individuals were found of diatoms belonging to 14 species.

Sample 7.—Collected in the Wang Yu, *Othonias undovittatus* (Jordan & Seale) fishing ground, south of Quamoy Island, Amoy, May 6, 1936. Noctiluca was predominant. Only 9 species of diatoms were recorded.

Sample 8.—Collected in the disc fish, *Evynis cardinalis* (Lacepede) fishing ground, east of Tung Ting Light House, Amoy, May 27, 1936. Only 3 species were obtained.

Sample 9.—Collected in the White Chang Yu, *Stromateus argenteus* (Euphrasen) fishing ground, June 6, 1936. The collecting ground of this sample was very near Tung Ting Light House. Ten species were found.

Sample 10.—Collected between Amoy and Formosa, November 27, 1936. Twelve species were found.

Sample 11.—Collected in front of Amoy Light House, January 15, 1937. Four species were obtained.

Sample 12.—Collected between Amoy and Kulangsu Island, in 1932. Twenty-six species were recorded.

Sample 13.—Collected from Tungsan Island, south of Amoy, August 31, 1936. Numerous diatoms were found, belonging to 55 species.

DIATOMS FOUND

MELOSIRA MONILIFORMIS (Müll.) Agardh.

Found in samples 4 and 12. Reported from Amoy by Chin.

MELOSIRA JUERGENSI Agardh.

Found in sample 4. Reported from Amoy.

PARALIA SULCATA (Ehr.) Cleve.

Found in samples 3, 5, 6, 7, 8, 10, and 13. Reported from Amoy and Tsingtao by Chin.

PODOSIRA STELLIGER (Bail.) Mann.

Podosira stelliger (Bail.) Mann, HUSTEDT (1928) 286, fig. 128.

Found in sample 3. Reported from Foochow by Skvortzow.

STEPHANOPYXIS TURRIS (Grev. & Arn.) Ralfs.

Found in sample 2. Reported from Tsingtao.

STEPHANOPYXIS PALMERINA (Grev.) Grunow.

Found in samples 10 and 13. Reported from Amoy and Tsingtao.

SKELETONEMA COSTATUM (Grev.) Cleve.

Found in sample 13. Reported from Amoy and Tsingtao.

ACTINOCYCLUS EHRENBERGI Ralfs.

Actinocyclus Ehrenbergi Ralfs, HUSTEDT (1929) 525, fig. 298.

Found in samples 3 and 12. Reported from Ningpoo by Petit.

THALASSIOSIRA NORDENSKIOLDI Cleve.

Thalassiosira nordenskioldi Cleve, LEBOUR (1930) 57, fig. 29.

Found in sample 13. First record for China Coast.

COSCINODISCUS NOBILIS Grunow.

Coscinodiscus nobilis Grunow, ALLEN & CUPP (1935) 118, fig. 13.

Found in samples 3 and 12. First record for China Coast.

COSCINODISCUS RADIATUS Ehrenberg.

Found in samples 1, 3, 4, 6, 8, 9, 11, and 12. Reported from Tsingtao.

COSCINODISCUS ASTEROMPHALUS Ehrenberg.

Found in samples 2, 6, 7, 10, 12, and 13. Reported from Amoy and Tsingtao.

COSCINODISCUS EXCENTRICUS Ehrenberg.

Found in samples 1, 2, 3, 5, 6, 11, 12, and 13. Reported from Amoy and Tsingtao.

COSCINODISCUS LINEATUS Ehrenberg.

Found in samples 1, 3, 4, 6, 7, 12, and 13. Reported from Amoy and Tsingtao.

COSCINODISCUS JANISCHII A. Schmidt.

Found in samples 3, 5, and 12. Reported from Amoy and Tsingtao.

COSCINODISCUS JONESIANUS (Grev.) Oster.

Coscinodiscus Jonesianus (Grev.) Oster., ALLEN & CUPP (1935) 116, fig. 10.

Found in samples 3, 12, and 13. First record for China Coast.

COSCINODISCUS MARGINATUS Ehrenberg.

Coscinodiscus marginatus Ehrenberg, ALLEN & CUPP (1935) 115, fig. 7.

Found in sample 12. Reported from China Sea by Hutton.

COSCINODISCUS CURVATULUS Grunow.

Found in sample 12. Reported from Amoy.

COSCINODISCUS SUBTILIS (Ehr.) Grunow.

Coscinodiscus subtilis (Ehr.) Grunow, V. H. (1896) 532, pl. 34, fig. 901.

Found in sample 2. First record for China Coast.

PLANKTONIELLA SOL (Wall.) Schuett.

Found in sample 4. Reported from Amoy.

CYCLOTELLA COMTA (Ehr.) Kützing.

Found in samples 3, 12, and 13. Reported from Amoy.

CYCLOTELLA STRIATA (Kütz.) Grunow.

Found in samples 12 and 13. Reported from Amoy and Tsingtao.

CYCLOTELLA STYLORUM Bright.

Cyclotella stylorum Bright, HUSTEDT (1928) 348, fig. 179.

Found in sample 2. First record for China Coast.

ACTINOPTYCHUS UNDULATUS (Bail.) Ralfs.

Found in samples 1, 2, 3, 4, 6, 7, and 13. Reported from Amoy and Tsingtao.

ASTEROMPHALUS FLABELLATUS Greville.

Asteromphalus flabellatus Greville, HUSTEDT (1928) 498, fig. 279.

Found in sample 3. First record for China Coast.

CORETHRON PELAGICUM Brun.

Found in samples 1, 3, 6, and 13. Reported from Amoy.

CORETHRON HYSTRIX Hensen.

Found in samples 7, 10, and 13. Reported from Amoy.

LAUDERIA ANNULATA (Cl.) Castr.

Lauderia annulata (Cl.) Castr., ALLEN & CUPP (1935) 124, fig. 25.

Found in sample 12. Reported from Hongkong by Greville.

LAUDERIA BOREALIS Gran.

Lauderia borealis GRAN (1927) 23, fig. 22.

Found in samples 3, 5, and 13. Reported from Hongkong by Lauder.

GUINARDIA FLACCIDA (Castr.) Peragallo.

Guinardia flaccida (Castr.) Peragallo, ALLEN & CUPP (1935) 125, fig. 28.

Found in sample 13. First record for China Coast.

RHIZOSOLENIA SETIGERA Brightwell.

Found in samples 6, 9, and 12. Reported from Amoy and Tsingtao.

RHIZOSOLENIA STOTERFORTHII H. Peragallo.

Found in samples 2 and 13. Reported from Amoy and Tsingtao.

RHIZOSOLENIA ALATA fo. INDICA (Perag.) Oster.

Found in samples 1, 2, 9, and 13. Reported from Amoy and Tsingtao.

RHIZOSOLENIA ALATA fo. GENUINA Gran.

Found in sample 13. Reported from Amoy.

RHIZOSOLENIA ALATA fo. GRACILLIMA (Cl.) Grunow.

Rhizosolenia alata fo. *gracillima* (Cl.) Grunow, ALLEN & CUPP (1935) 131, fig. 44.

Found in sample 13. First record for China Coast.

RHIZOSOLENIA ROBUSTA Norm.

Found in sample 13. Reported from Amoy.

RHIZOSOLENIA CALCAR AVIS M. Schultze.

Found in samples 9 and 13. Reported from Amoy.

RHIZOSOLENIA ACUMINATA (Perag.) Gran.

Found in samples 9 and 13. Reported from Amoy.

RHIZOSOLENIA IMBRICATA var. SHRUBSOLII (Cl.) V. Heurck.

Found in samples 3 and 13. Reported from Amoy.

CHAETOCEROS COARCTATUS Lauder.

Found in samples 3, 5, 6, 7, 9, and 12. Reported from Amoy.

CHAETOCEROS EIBENII (Grun.).

Found in samples 1, 3, and 9. Reported from Amoy and Tsingtao.

CHAETOCEROS AFFINIS Lauder.

Found in samples 3, 5, 10, and 13. Reported from Amoy.

CHAETOCEROS PSEUDOCURVISETUM Manguin.

Found in sample 13. Reported from Tsingtao.

CHAETOCEROS DENSUS Cleve.

Found in sample 13. Reported from Tsingtao.

CHAETOCEROS PERUVIANUS Brightwell.

Found in sample 13. Reported from Amoy and Tsingtao.

CHAETOCEROS COMPRESSUS Lauder.

Chaetoceros compressus Lauder, ALLEN & CUPP (1935) 138, fig. 60.

Found in sample 13. Reported from Hongkong by Lauder.

CHAETOCEROS PELAGICUS Cleve.

Chaetoceros pelagicus Cleve, LEBOUR (1930) 137, fig. 100.

Found in samples 9 and 13. First record for China Coast.

CHAETOCEROS BOREALIS Bail.

Found in sample 13. Reported from Amoy.

CHAETOCEROS LORENZIANUS Grunow.

Found in sample 13. Reported from Tsingtao.

CHAETOCEROS DECIPIENS Cleve.

Found in samples 9 and 10. Reported from Amoy and Tsingtao.

BACTERIASTRUM HYALINUM Lauder.

Found in samples 3, 5, 12, and 13. Reported from Amoy.

TRICERATIUM FAVUS Ehrenberg.

Found in samples 3, 12, and 13. Reported from Amoy and Tsingtao.

ACTINOPTYCHUS ANNULATA (Wall.) Grunow.

Found in sample 3. Reported from Amoy.

CERATAULINA BERGSONII H. Peragallo.

Found in sample 13. Reported from Amoy.

DITYLIUM BRIGHTWELLII (West) Grunow.

Found in samples 3, 5, 6, 10, 12, and 13. Reported from Amoy and Tsingtao.

DITYLIUM SOL Grunow.

Found in sample 3. Reported from Tsingtao.

BIDDULPHIA AURITA (Lyng.) Brebisson.

Found in sample 12. Reported from Amoy.

BIDDULPHIA PULCHELLA Gray.

Found in sample 12. Reported from Amoy.

BIDDULPHIA SINENSIS Greville.

Found in samples 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, and 13. Reported from Amoy and Tsingtao.

BIDDULPHIA RHOMBUS (Ehr.) W. Sm.

Biddulphia rhombus (Ehr.) W. Sm., HUSTEDT (1930) 842, fig. 96, 97.

Found in sample 4. First record for China Coast.

BIDDULPHIA LEAVIS Ehrenberg.

Found in sample 4. Reported from Amoy and Tsingtao.

BIDDULPHIA MOBILIENSIS (Bail.) Grunow.

Found in samples 5 and 13. Reported from Amoy and Tsingtao.

BIDDULPHIA AURITA var. **OBTUSA** (Kütz.) Hustedt.

Biddulphia aurita var. *obtusa* (Kütz.) Hustedt, LEBOUR (1930) 179, fig. 139.

Found in sample 4. Reported from Foochow by Skvortzow.

BIDDULPHIA GRANULATA Roper.

Found in samples 6 and 10. Reported from Amoy.

HEMIAULUS SINENSIS Greville.

Found in sample 13. Reported from Amoy and Tsingtao.

EUCAMPIA ZODIACUS Ehrenberg.

Found in sample 13. Reported from Amoy and Tsingtao.

CLIMACODIUM FRAUENFELDIANUM Grunow.

Found in sample 13. Reported from Amoy.

STREPTOTHECA THAMENSIS Shrubs.

Found in sample 10. Reported from Tsingtao.

RHAPHONEIS AMPHICEROS Ehrenberg.

Rhaphoneis amphiceros Ehrenberg, VAN HEURCK (1936) 330, fig. 394.

Found in sample 1. First record for China Coast.

THALASSIOTHRIX FRAUENFELDII (Grun.) Cleve & Grunow.

Found in samples 3 and 13. Reported from Amoy and Tsingtao.

THALASSIOTRIX LONGISSIMA Cleve & Grunow.

Found in sample 13. Reported from Amoy and Tsingtao.

THALASSIOTHRIX NITZSCHIOIDES Grunow.

Found in samples 6, 7, and 13. Reported from Amoy and Tsingtao.

ASTERIONELLA NOTATA Grunow.

Asterionella notata GRUNOW (1927) 119, fig. 126.

Found in sample 13. First record for China Coast.

ASTERIONELLA JAPONICA Cleve.

Found in sample 13. Reported from Amoy and Tsingtao.

RHABDONEMA ADRIATICUM Kützing.

Found in sample 2. Reported from Tsingtao.

GRAMMATOPHORA MARINA (Lyn.) Kützing.

Found in sample 4. Reported from Amoy and Tsingtao.

LICMOPHORA ABBREVIATA Agardh.

Found in samples 1, 4, and 11. Reported from Amoy and Tsingtao.

ACHNANTHES BREVIPES Agardh.

Found in samples 1, 3, and 4. Reported from Amoy.

TRACHYNEIS ASPERA (Ehr.) Cleve.

Trachyneis aspera (Ehr.) Cleve, DONKIN (1870) 62, pl. 10, fig. 1.

Found in samples 1, 2, 3, 4, and 12. First record for China Coast.

DIPLONEIS SMITHII (Berg.) Cleve.

Diploneis smithii (Berg.) Cleve, DONKIN (1870) 6, pl. 2, fig. 5.

Found in sample 1. Reported from Ningpoo by Petit, and from Foochow and Dairen by Skvortzow.

NAVICULA CRABRO (Ehr.) Kützing.

Navicula Crabro (Ehr.) Kützing, DONKIN (1870) 64, pl. 7, fig. 1.

Found in samples 1 and 12. First record for China Coast.

NAVICULA LONGA Greg.

Navicula longa Greg., DONKIN (1870) 55, pl. 8, fig. 7.

Found in samples 2 and 3. Reported from Ningpoo and Nimrod Sound by Petit.

NAVICULA PRAETEXTA Ehrenberg.

Navicula praetexta Ehrenberg, DONKIN (1870) 10, pl. 2, fig. 1.

Found in sample 1. First record for China Coast.

NAVICULA SPECTABILIS Greg.

Navicula spectabilis Greg., DONKIN (1870) 12, pl. 2, fig. 5.

Found in sample 1. First record for China Coast.

NAVICULA INTERRUPTA Kützing.

Navicula interrupta Kützing, DONKIN (1870) 47, pl. 7, fig. 2.

Found in sample 13. First record for China Coast. Brackish-water species.

NAVICULA CANCELLATA Donkin.

Found in sample 3. Reported from Amoy and Tsingtao.

AMPHORA OSTREARICA Brebisson.

Amphora ostrearica Brebisson, VAN HEURCK (1896) 139, pl. 1, fig. 1.

Found in sample 12. First record for China Coast.

PLEUROSIGMA ANGULATUM W. Sm.

Found in samples 2, 3, 6, 7, 12, and 13. Reported from Tsingtao.

PLEUROSIGMA ANGULATUM var. STRIGOSA W. Sm.

Pleurosigma angulatum var. *strigosa* W. Sm., ALLEN & CUPP (1935) 158, fig. 108.

Found in sample 13. First record for China Coast.

PLEUROSIGMA RECTUM Donkin.

Pleurosigma rectum Donkin, ALLEN & CUPP (1935) 158, fig. 111.

Found in sample 3. First record for China Coast.

PLEUROSIGMA NORMANII Ralfs.

Found in sample 3. Reported from Tsingtao.

PLEUROSIGMA FORMOSUM W. Sm.

Found in sample 4. Reported from Amoy.

GYROSIGMA BALTICUM W. Sm.

Found in sample 1. Reported from Amoy.

SURIRELLA FLUMINENSIS Grunow.

Surirella fluminensis Grunow, ALLEN & CUPP (1935) 164, fig. 126.

Found in samples 3 and 13. Reported from Dairen and Foochow by Skvortzow.

SURIRELLA GEMMA Ehrenberg.

Surirella gemma Ehrenberg, ALLEN & CUPP (1935) 164, fig. 125.

Found in samples 3 and 13. Reported from Nimrod Sound by Petit, and Dairen by Skvortzow.

CAMPYLODISCUS (?) COCCONEIFORMIS Grunow.

Campylodiscus (?) *cocconeiformis* Grunow, ALLEN & CUPP (1935) 165, fig. 127.

Found in samples 3 and 13. First record for China Coast.

BACILLARIA PARADOXA Gmelin.

Found in samples 3, 10, and 13. Reported from Amoy and Tsingtao.

NITZSCHIA LORENZIANA Grunow.

Nitzschia Lorenziana Grunow, VAN HEURCK (1896) 405, pl. 17, fig. 572.

Found in sample 12. First record for China Coast.

NITZSCHIA PUNCTATA (W. Sm.) Grunow.

Nitzschia punctata (W. Sm.) Grunow, VAN HEURCK (1896) 384, pl. 15, fig. 491.

Found in sample 2. Reported from Ningpoo by Petit. Brackish-water species.

NITZSCHIA TRYBLIONELLA var. LITTORALIS Grunow.

Nitzschia tryblionella var. *littoralis* Grunow, VAN HEURCK (1896) 385, pl. 15, fig. 496.

Found in sample 1. First record for China Coast. Brackish-water species.

NITZSCHIA PANDURIFORMIS Grunow.

Nitzschia panduriformis Grunow, VAN HEURCK (1896) 386, pl. 15, fig. 500.

Found in sample 3. Reported from Ningpoo by Petit, and from Dairen by Skvortzow.

NITZSCHIA DELICATISSIMA Cleve.

Found in sample 13. Reported from Tsingtao.

NITZSCHIA LONGISSIMA (Breb.) Gran.

Found in samples 10 and 13. Reported from Amoy and Tsingtao.

NITZSCHIA SERIATA Cleve.

Found in sample 13. Reported from Amoy and Tsingtao.

NITZCHIA CLOSTERIUM (Ehr.).

Nitzschia closterium (Ehr.), LEBOUR (1930) 212, fig. 179.

Found in sample 4. First record for China Coast.

BINARY, BINOMIAL, AND BIVERBAL NAMES

By C. X. FURTADO

Of the Botanic Gardens, Singapore

From time to time botanists are called upon to decide whether or not certain specific names are binary or binomial within the meaning of the International Rules of Botanical Nomenclature, edition 1935. Some nomenclaturists would reject as not binary such names as *Asplenium Trichomanes dentatum* L. (1753), *Impatiens noli tangere* L. (1753), *Adiantum capillus veneris* L. (1753), *Strychnos nux vomica* L. (1753), *Xanthophytum Johannis Winkleri* Merr. (1937), and *Tibouchina Campos Portoi* Brade (1938), because the names are composed, in each case, of three separate words [1] but others do not agree to this rejection. This division of opinion among botanists upon so fundamental a point has been productive of many debates and contrary proposals, none of which have brought us nearer to a final decision.

If *Asplenium Trichomanes dentatum* L. (1753) and *A. Trichomanes ramosum* L. (1753) are not binary names, the proposal to reject them, put forward at the last Botanical Congress (1935), was not in order; for these are specific names, and the rule is that nonbinary specific names are invalid (Articles 27, 67, and 68); and consequently, such names have no status under the Rules and no claim to recognition can be made for them. If, however, the names cited are binary, the proposal to reject them, put forward at the Congress, was not given the consideration due to it from the legislative body at that Congress.

Actually, however, both interpretations are possible, because the definition of the term "binary," according to the way it has been used in the Rules and currently employed by taxonomists, is equivocal. In some instances it is used with the meaning biverbal; in other instances it is used with the meaning binomial or binary (all as defined below). Obviously, then, the first step to be taken in this matter must be to define unequivocally the terms, binary, binomial (or binominal), and biverbal, by restricting the use of the terms as follows:

[1] See also Sprague, Synopsis of Proposals, Amsterdam Congress (1935) 75, App. V.

A name is biverbal when it consists of two distinct words; it is binary when it refers to two valid descriptions, one generic and the other specific (under certain circumstances it is possible to combine these two descriptions—Article 43); and it is binomial (or binominal) when it consists of two appellations or epithets, each referring to one valid description of which neither of the appellations or epithets forms a part.

To be valid a specific name must, therefore, be a binary binomial, and usually a biverbal (Article 27).

The Linnæan system of nomenclature as promulgated in 1753 was essentially binary and binomial, and generally, though not universally, biverbal. Owing, however, to the efforts made by Linnæus himself and others subsequent to the publication of Species Plantarum (1753) to make the system also essentially biverbal, the three fundamental characteristics of the system were soon overlooked, and the terms biverbal, binary, and binomial came to be employed equivocally as if they were, in every case, interchangeable. This is unfortunate, as it leads to many erroneous conclusions and causes uncertainty in the application of the Rules. It is therefore desirable to adopt definitions that will emphasize the triple aspect of modern botanical nomenclature. In proposing the above definitions for wider acceptance I have kept this purpose in view.

EXAMPLES

Rumphius's Herbarium Amboinense is invalid under the Rules because it was published before 1753 (Article 20). Had it been published after 1753, *Limo decumana* Rumph. would have been classed as a biverbal name of the unitary class, because it refers to only one description, namely, the specific description. Similarly, neither *Villebrunnea integrifolia* Gaud. nor *V. crenulata* Gaud. (1844 to 1866) can be called a binary or binomial, because individually they refer to only one valid description, namely, that of a species, there being, at the time of publication of these biverbals, no valid description of a genus known as *Villebrunnea!* Both the biverbal names must, therefore, be classed among the unitary names of species.

On the other hand, *Apocynum foliis Androsaemi* L. (1753), cited in Article 68 as an example of a nonbinary name, is a binary binomial according to the definitions given above, although it is not a biverbal: it belongs to the same category of the triverbal specific names as *Adiantum capillus veneris* L. (1753)

and *Impatiens noli tangere* L. (1753) whose specific epithets, though biverbal when originally published, have now to be transformed, under the provisions of Article 27, into univerbals by uniting or hyphening the two words in each of the specific epithets, so that the entire binomials may become biverbals.

The works of Linnæus published before 1753 are invalid under Article 20; but had they been published after 1753, the specific names in them would have to be included as binary, because each name refers to two descriptions, generic and specific; but because in these works there was no specific epithet quite distinct from the specific diagnosis or description, none of the specific names could have been considered as a binomial, despite the fact that some of them are biverbal.

Biverbal names given to varieties in Gandoger's Flora Europae (1883 to 1891) are binomial, because each name consists of two appellations or epithets not forming a part of any description, and each appellation or epithet refers to one invalid description; but they are not binary, because the description indicated by the second epithet is not that of a species. Gandoger's biverbal binomial names for varieties are of the same category as *Bougainvillea* "Mrs. Butt" where each name, though binomial in form, implies at least three taxonomic groups or descriptions, namely, a particular description of a variety or form called "Mrs. Butt." belonging to a particular species or hybrid (implied), which in its turn, belongs to the genus *Bougainvillea.*

BOOKS

Books reviewed here have been selected from books received by the Philippine Journal of Science from time to time and acknowledged in this section.

REVIEWS

Problems of the Pacific, 1936. Aims and Results of Social and Economic Policies in Pacific Countries. Proceedings of the Sixth Conference of the Institute of Pacific Relations, Yosemite National Park, California, 15–29 August, 1936. Edited by W. L. Holland and Kate L. Mitchell, Assisted by Harriet Moore and Richard Pyke. Chicago, University of Chicago press. 470 pp. Price, $5.

In its sixth conference held in Yosemite, California, the Institute of Pacific Relations discussed the aims and results of social and economic policies in the major Pacific countries. The monetary policy of the United States as developed by the New Dealers has favorable effects on Canadian exports, but it proved disastrous to Chinese economy where it accentuated the decline in commodity prices and the decline in national income.

There was also a discussion of Japanese trade competition in India and in the Philippines, where the Japanese drive had telling effects notably in cotton piece goods. This competition in the former country caused the closing of many cotton mills in Lancashire. At the height of this competition, Japanese trade was slightly higher than it was 15 years ago. This gain was viewed with alarm by the Western countries, notwithstanding the fact that Japan had increased her population by 20 per cent. The exaggeration of this expansion may be due to the fact that it took place in the midst of the most difficult period of the world's commercial history. To achieve it Japan had to rationalize her industries and utilize technological development. The British charged that this competition proved ruinous not only to the British and American exporters but also to the Japanese themselves because the prices were unnecessarily low. It was also held that whatever profit Japan could make in this trade was used to finance Japanese aggressive wars.

The Russian delegates, who for the first time attended the Conference, claimed that Russia has reached the stage of socialism,

an economy in which the vast majority of the means of production is socially owned. This socialism brings in its wake the establishment of a classless society in which every group has fundamentally similar economic interests.

For the preservation of peace in the Pacific area, the Soviets believe in collective security enforced by sanctions. The Japanese urgently advocated bilateral agreements for the adjustment of specific disputes; they favored the negotiation of such agreements between Russia and Japan and between Japan and China prior to any attempt at a more general agreement. The British and the Americans desired a general consultative pact and periodic conferences of the Pacific Powers to discuss possible causes of friction before these get out of control.

The last half of the book is a series of articles describing the economic and social conditions of the United States, Soviet Russia, China, and Japan. The conflicting commercial interests of these countries and the desire for raw materials on the part of Japan to feed her industries are sources of misunderstandings. In the last article the writer points to a series of treaties evolved for the maintenance of peace in the Pacific area, which were consistently violated by the unilateral action of Japan.—G. P.

1937 Bibliography of Rubber Literature (Excluding Patents). Compiled By Donald E. Cable. New York, The Rubber Age, 1938. 128 pp. Price, paper, $1; cloth, $2.

This compilation contains references to articles on rubber published in various journals during 1937. It is the third of a series of annual rubber bibliographies which was started in 1935. A cursory examination of this book reveals that the compiler spared no effort in assembling within its covers a complete list of the latest information on the subject. It opens with a table of contents, giving the different subjects, in alphabetical arrangement, into which the bibliography is divided. A list of the journals consulted follows, giving both the abbreviated and the full title and the publisher and address of each periodical. The bibliography is divided into 75 subjects or sections arranged alphabetically with cross references at the end of each section. The book continues the unique method of its predecessors in identifying references. It closes with adequate author and subject indexes. It is handy and should prove useful to those engaged in the rubber industry.—Q. A. E.

A Manual of Operating Room Procedures. By Almira W. Hoppe and Lucile M. Halverson, Assisted by the Operating Room Nursing Staff of the University of Minnesota Hospitals. Minneapolis, The University of Minnesota press, c1937. 239 pp. Loose leaf. Price, $4.

This handbook outlines systematically all the minute particulars of preparation for operation and operative procedure and emphasizes the importance of a planned, orderly conduct as essential to the safety of the patient, poise and equanimity of the surgeon, and the final success of the operation. The outline covers all operations of general, gynecological, urological, orthopœdic and ear, eye, nose, and throat surgery, and while it is essentially intended to serve as a guide to the surgical nurse, it should also be useful to the medical student and the surgical practitioner.—B. S. G.

Eat and Keep Fit. By Jacob Buckstein. New York, Emerson books, Inc., 1938. 128 pp. Price, $1.

The author has ably and concisely presented the essential facts about the body's requirements and the relation of food to health and physical fitness. The book contains valuable advice on diets for gaining or reducing weight. The presentation of the subject matter is clear and to the point. This little book can be recommended to any person who wants to know what he should eat to become fit.—I. C.

A Survey of Methods of Care, Treatment, and Training of the Feebleminded together with a Program for the Future. By C. E. A. Winslow, William Crocker, Ford, Bacon, and Davis, Inc., C. W. Munger, Frederick Law Olmsted, Lowell J. Reed, Bruce B. Robinson, Arthur H. Ruggles, Edward F. Stevens. Foreword by Frederick W. Parsons. Introduction by Franklin B. Kirkbride. Made at Letchworth Village, Thiells, New York, 1937. Utica, New York, State Hospitals press, 1937. 164 pp., illus., front.

This volume is heartily dedicated to the genius in Administration and master in planning, the late Charles Sherman Little, M.D., ScD., the pioneer who paved the way towards an almost perfect care, treatment, and training for the feebleminded.

This book records a good number of constructive and instructive ideas which are highly interesting and important for psychologists and psychiatrists. It teaches that institutions like the Letchworth Village should be "a home, a school, and a laboratory"; in it are enumerated the four primordial purposes of the institution, as follows:

To relieve the family and the community of the care of persons whose development is so arrested that they constitute a serious burden.

To limit the propagation of genetically inferior stock by segregation.

To provide humane custodial care for persons of such low grade of development.

To rehabilitate such persons under care as are capable of material improvement.

In this book is also described the developmental progress of Letchworth Village, under the untiring efforts of Charles S. Little, whose sole craving was to see that in a quarter of a century a stately institution be erected to house and rehabilitate the unfortunates whose mentalities are below par but who are normal in every respect of physical development—those who are considered by the social world to be utterly serious social burdens. It also gives a description of how and where an institution like Letchworth Village should be built.

The book is divided into five constructive parts: (1) Physical plant, which describes the general physical plan, architecture, sanitation, mechanical equipment, and soil conditions and farming; (2) care of patients, which includes medical service, nursing service, hospital service, out-patient department service, dental service, research service, psychological service, social service work, etc.; (3) educational procedure; (4) administration; and (5) statistic and research. It is profusely illustrated.

—F. S. S. M.

The Troubled Mind. A General Account of the Human Mind, and its Disorders and Their Remedies. By Harry Roberts. With Chapters on the Insanities by Margaret Nelson Jackson. London, John Murray, 1938. 284 pp. Price, 6s.

This book is a treasure chest wherein are recorded the precious surveys of the mental disorders that only a man like Dr. Harry Roberts, with a vast, successful experiences behind him, can competently write on to guide not only the psychiatrists but also the general reader. Doctor Roberts expresses his ideas on the unfavorable and varied circumstances that the human mind has to undergo in this modern era. He deals with the various known mental diseases of both children and adults, their causes, and methods of rational treatment. He holds the view that mental diseases are like other somatic diseases which lend themselves to treatment. He tries to efface the erroneous conception deeply rooted in the minds of mankind that once an insane, always an insane, by the process and aid of psychoanalysis and psychotherapy.

The author divides the book into two comprehensive halves. In the first half he dexterously begins with the "mind," defining it and enumerating its functions. The subconscious mind, its complexes and conflicts, and the emotions and their sublimations are discussed in detail. He includes a discussion of the primal urges of mankind.

In the second half he and M. N. Jackson discuss the insanities and their various types and remedies.

Margaret Nelson Jackson closes the book with chapters on the psychoses, their inheritance and predisposing causes, such as intoxication, infections, exhaustion, age, and sex. She described in detail the manic-depressive states, schizophrenia (cleavage of the personality), persecution mania of the paranoid reaction, the syphilitic psychoses, drug addictions, mental deterioration, and mental disorders due to endocrine disfunctions. She mentions the treatment of neuroses by psychoanalysis and suggestion and of psychoses by psytherapy, sedative methods, and occupational therapy. She dwells on the mental defectives, their classification, clinical types, predisposing causes, and treatment. She closes her discussion with a statement on guards of the mentally sick.—F. S. S. M.

Childless. By Sam Gordon Berkow. New York, Lee Furman, Inc., 1937. 307 pp. Price, $3.

One is likely to judge superficially a book with a title such as this one. A perusal of its contents, however, convinces the reader that the author is guided by the most serious of motives. He treats the subject scientifically, without forgetting that the book is designed chiefly for lay readers numbering about 2,000,000 childless couples in America alone, who need badly the information which it gives. The discussion of the so-called safe period theories is critical but sound. The fairly comprehensive bibliography at the end shows not only the thorough manner in which the author prepared himself before writing the book but it is a very useful guide to readers who may wish further light on any particular phase of the broad subject of sterility or childlessness.—C. R.

Sick Children: Diagnosis and Treatment. A Manual for Students and Practitioners. By Donald Paterson. London, Cassell and company, Ltd., 1938. 3d. ed. 604 pp., illus. Price, 12s. 6d.

The first five chapters of this book deal with elementary knowledge of the attributes of the normal infant and the abnormalities that are met with in this period of life; the diseases and injuries

that follow birth; the care and feeding of the premature infant; the feeding of the normal infant and the child; and the diseases of nutrition.

The discussion of the diseases of the various organs and systems are taken up in turn in the succeeding chapters. Each of the diseases taken up is briefly but concisely discussed. Etiology with its contradicting views is given but a passing mention. Only the fundamentals of the pathology of each disease is given. The clinical picture of each disease as essential to the main purpose of the book, that of its diagnosis and treatment, is emphasized and treated in detail.

The last chapters are devoted to discussions on tuberculosis, rheumatism, diabetes, intestinal parasites (worms), and syphilis in childhood. The main features of the discussion on the diseases of the organs and systems are the presentation of the clinical picture of each disease in its varied forms and its treatment.

The materials taken up in this book are well condensed and simply treated. The book is a handy reference and can be easily understood. The beginner in pediatrics this book will prepare and initiate into a more comprehensive understanding of the detailed works on the subject; the busy practitioner with his few hours to spare it serves as a ready reference. The field nurse in charge of infant hygiene can use it as a constant guide in her daily work. The book contains many plates and illustrations. The references cited in the text further enhance its value.—J. A.

RECEIVED

A. S. T. M. standards on petroleum products and lubricants. Prepared by Committee D-2 on petroleum products and lubricants. Methods of testing specifications, definitions, charts, and tables. Philadelphia, American society for testing materials, October, 1938. 311 pp., illus. Price, $2.

A. S. T. M. standards on textile materials. Prepared by Committee D-13 on textile materials. Specifications, tolerances, methods of testing, definitions, and terms. Philadelphia, American society for testing materials, October, 1938. 323 pp., illus. Price, $2.

ALLEN, GLOVER M. The mammals of China and Mongolia. Natural history of Central Asia, vol. XI, Part 1. New York, The American museum of natural history, 1938. 620 pp., maps, pl., illus. Price, $10.

American institute of mining and metallurgical engineers (incorporated). Transactions vol. 127. Petroleum development and technology 1938. Petroleum division. Papers and discussions presented before the division at meetings held at Los Angeles, Oct. 1, 1937; Oklahoma City,

Oct. 7–9, 1937; New York, Feb. 14–18, 1938. New York, American institute of mining and metallurgical engineers (incorporated), 1938. 744 pp., illus. Price, $5.

BARTON, R. F. Philippine pagans the autobiographies of three Ifugaos. London, George Routledge & Sons, Ltd., 1938. 271 pp., front., illus. Price, 15s.

BRAUER, OSCAR L. Chemistry and its wonders. New York, American book company, 1938. 760 pp., front., illus. Price, $2.

BRAUER, OSCAR L. Exploring the wonders of chemistry. A workbook and laboratory guide. New York, American book company, c1938. 246 pp., illus. Price, paper, $0.48.

The extra pharmacopoeia. Martindale. Twenty-first edition in two volumes, vol. II. Published by direction of the council of the Pharmaceutical society of Great Britain. London, The Pharmaceutical press, 1938. 1,148 pp. Price, 22s. 6d.

HOPPE, ALMIRA W., and LUCILE M. HALVERSON. A manual of operation room procedures. Assisted by the operating room nursing staff of the University of Minnesota hospitals. Minneapolis, The University of Minnesota press, 1938. 239 pp. Loose leaf. Price, $2.

HORVATH, A. A. The soybean industry. New York, The Chemical publishing company of New York, inc., 1938. 221 pp. Price, $4.

MADISON, HAROLD L. Wild flowers of Ohio. Cleveland, Ohio, The Cleveland museum of natural history, c1938. 190 pp., illus.

MORRELL, ROBERT SELBY, and Others, eds. Synthetic resins and allied plastics. London, Oxford University press, 1937. 417 pp., illus. Price, $11.

NASH, JAY B. Teachable moments. A new approach to health. New York, A. A. Barnes and company, 1938. 243 pp. Price, $1.50.

ORNSTEIN, MARTHA. The rôle of scientific societies in the seventeenth century. Chicago, The University of Chicago press, c1938. 3d. ed. 308 pp., illus. Price, $3.

PARKER, RAYMOND C. Methods of tissue culture. With a foreword by Alexis Carrel. New York, Paul B. Hoeber, inc., 1938. 292 pp., front, illus. Price, $5.

SANTE, L. R. Manual of roentgenological technique. Ann Arbor, Edwards brothers, inc., 1938. 228 pp., front., illus. Price, $4.50.

VEITCH, ROBERT. Insect pests and their control. Issued by direction of the Hon. F. W. Bulcock, Secretary for agriculture and stock. Reprinted from volume III of the Queensland agricultural and pastoral handbook, published by the Department of Agriculture and Stock, Brisbane, 1938. 119 pp., illus.

ZHITKOVA, A. A. Some methods for the detection and estimation of poisonous gases and vapors in the air. A practical manual for the industrial hygienist. Edited and with an introduction by Professor S. I. Kaplun. Translated under direction of Joseph B. Ficklen. West Hartford, Connecticut, c1936. 198 pp., illus. Price, $3.

ERRATA

VOLUME 67

Page 255, line 20, for *Elmer 13931* read *Elmer 13531.*

Page 259, cancel line 29.

Page 260, line 20, *for* 5 to 6 cm long *read* 5 to 6.5 cm long.

Page 271, insert the following diagnosis of *Anisoptera aurea* Foxworthy: A. Curtisii Dyer similis sed stamina majora et sepala aequalia.

Page 278, at end of line 10 insert: yacal.

Page 282, lines 15 and 21, *for* Leaf. Philip. Bot. 6 *read* Leaf. Philip. Bot. 4; last paragraph, first line, *for* Basilan *read* Sibuyan; same paragraph, line 3, for *12071* read *12289.*

Page 323, line 3 from bottom, *for* Leaf. Philip. Bot. 6 *read* Leaf. Philip. Bot. 4.

Page 327, for first 3 lines *read:* Palawan, Puerto Princesa, Mount Pulgar, April, 1911, *Elmer 13123* (type) ; also *Elmer 12754* from same locality (isotypes in Philippine National Herbarium).

INDEX

[New names and new combinations are printed in **boldface**.]

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